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THE ECONOMIC CONQUEST OF AFRICA.

By H. G. Prout.

TO forecast the future of Africa I start with the assumption that the war will end in a peace dictated on England's terms. Setting aside the possibility of interference by continental Powers, there can be no other result. It would be superfluous to dwell upon the difference in war strength between the British Empire and a little inland State with 17,000 voters, even when that little State is helped by another little inland State and by some uprising of Dutchmen and half-breeds along the northern frontier of Cape Colony; if England were to choose to wear these people out by campaigns of attrition, avoiding heavy and bloody engagements, she could no doubt do it. It is evident, however, that she will choose a speedier course, involving more loss of life at the outset, but probably cheaper in the end. The disparity in mechanical skill and efficiency of the two peoples would settle the question if other things were near equal. Doubtless the German artillerists have made good gunners of some of these Boers and very possibly they have developed among them some fairly skillful subordinate artillery officers, but in the nature of things the number of men so trained by the Germans must be very small, and the same must be true of ordnance officers and of

Whatever the gloom of the present, far-seeing men will share Col. Prout's unshaken faith in the ultimate triumph of just and liberal government in Africa. And history shows that war is followed by periods of great prosperity. So it was with the United States after the Civil war, and more recently after the Spanish-American war; so it was in Ger-

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all those whose business it is to provide and care for ordnance and quartermasters' stores. But England completely controls the seas and the Boers cannot get in any new material. Therefore, as the material now collected is used up, and as the guns are disabled and as the trained artillerists are killed, the disparity between the combatants becomes greater.

We cannot stop now to analyze the military situation, but it may be well to say a word about a fallacy which seems to affect the notions of even intelligent people as to the outcome of this war. It is often said that England has fought no white men since the Crimea. What of that? For generations she has been engaged in incessant

PRIMITIVE TRAVEL IN SOUTH AFRICA. AN OX TEAM.

wars and oftentimes in desperate, although little, wars. Probably there is no other nation of whose officers and men so great a proportion has seen actual war. All of the older officers have had war after war. Many of the subalterns have made more than one campaign, as has a great proportion of the rank and file. This is not true of any continental army. The English are the most martial people now

many and in France after 1871. So it may be expected to prove, both in England and in Africa, with the close of the present struggle.

Col. Prout's long service with Gordon gave him an intimate knowledge of the resources and needs of Northern Africa. His authority as an expert in railway matters is everywhere known.

Recent articles in THE ENGINEERING MAGAZINE dealing with other aspects of the South African situation were:

The Transvaal Mines and the Boer Government. Dr. F. H. Hatch. Aug., 1899.
South African Questions from an Engineering Standpoint. Albert Williams, Jr. Dec., 1899.
John Hays Hammond on the South African Situation. Charles Buxton Going. Jan., 1900.

BRIDGE ON AN AFRICAN CARAVAN ROUTE.

walking about the face of this planet. They have had more fighting per man than any other people, and a great deal of their fighting has been with brave and stubborn, even if barbaric foes. There are few military incidents in the history of mankind so astonishing and so magnificent as the suppression of the Indian revolt of 1857. The breed that did that can be depended upon against any foe.

It is inconceivable that any of the European Powers should interfere. Interference would be too costly for the possible gain. It is possible that this war was precipitated to prevent such diplomatic entanglements as would have made one or more of the continental Powers the ally of the Boers in case of the war. This is the opinion of men expert in world politics, but that phase of the matter is past and that peril no longer stands.

What will England's terms be? Obviously, the Orange Free State and the Dutch Republic will cease to exist. Hereafter they can be only British colonies. It seems hardly worth while to go into the ethics of this matter. Whatever may be the right or wrong of the case, discussion of it is now in vain, except in so far as such discussion may help to build up moral sense among the peoples. The war has come, the outcome of it seems inevitable and the right and wrong has passed into the list of questions to be considered by historians and moralists. In passing, however, I will venture to quote a short paragraph from a manuscript document prepared by Chinese Gordon on the subject of the Egyptian advance into the country at the head of the Nile: "Whether a nation has the right to ad-

DUTCH TRADERS BUYING IVORY.

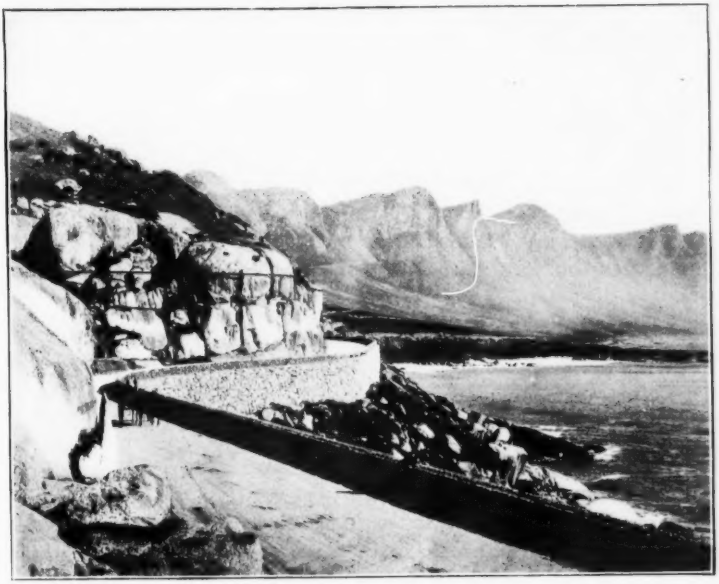
vance and annex the states of other peoples is a question solved by us practically. It can be theoretically discussed and decided on as unjust, but it is acted on practically in a different way." Surely Gordon was a man of a lively and exacting conscience. But he was also a man of a clear mind and of large observation of human affairs.

The struggle now going on in South Africa is merely one phase of the great race movement. It is a part of the ancient historical struggle to partition out the face of the earth. The continent of Africa must be divided up among the white peoples. The black and brown peoples who now occupy the continent belong to those inferior races which, in the struggle for existence, have to go to the wall. The question then is: How shall the continent be divided, and what white nations will possess it?

A KAFFIR KRAAL.

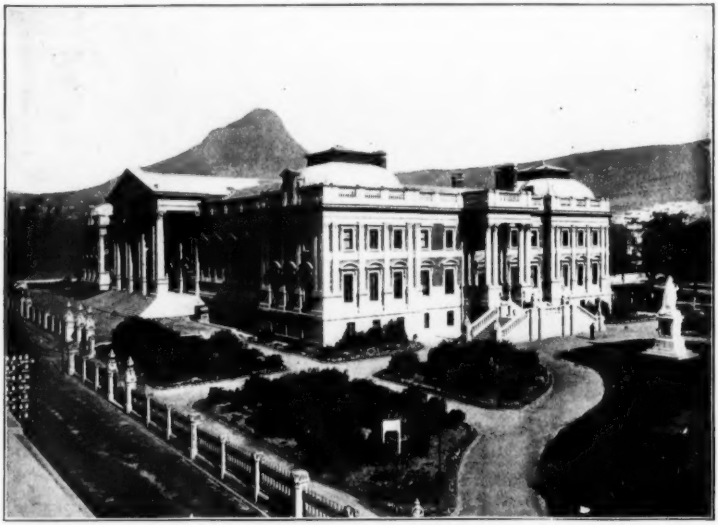
England occupies now the territory from the Cape to the south end of Lake Tanganyika—about 28 degrees of latitude. Within this territory are the South African Republic and the Orange Free State, which will henceforth be British. From latitude 25 south to latitude 11 south, England is shut off from the Indian Ocean by Portuguese East Africa, but south of that she has the coast line all the way around the Cape, and so up on the west side to about latitude 28. Obviously, to make this part of the British possessions most readily available for conquest and exploitation, England should have all of the Portuguese territory, and I take it that she will have this sooner or later. It may not come about by direct purchase, for the Portuguese are vain and impractical. It is possible that the wedge will be entered in the form

GENERAL VIEW OF CAPE TOWN.



CAPE TOWN. THE VICTORIA ROAD.

of a leasehold of the ports, which, after all, would answer England's purposes. Going farther north, German East Africa and the Congo Free State cut the British possessions in two for about 6 degrees of



THE PARLIAMENT HOUSES, CAPE TOWN

latitude, and then we come to British East Africa, as it is called, which includes the ancient kingdoms of Uganda and Unyoro, and all the country of the White Nile and the Gazelle River, to the tenth degree of north latitude. Then we get to the Egyptian Soudan, but Egypt and all the Egyptian Soudan have now become practically British colonies.

So England has a strip of Africa from the mouth of the Nile at the Mediterranean Sea the whole length of the continent to Cape Town, except the interruption of 5 degrees of latitude about the south side of Lake Victoria and including Lake Tanganyika. On the west coast she has the Niger territories of indefinite extent, including the mouth of the Niger and all the lower reaches of that stream. The British territories, including Egypt, the Egyptian Soudan, the South African Republic and the Orange Free State, will aggregate possibly 3,700,000 square miles.

The Germans control an area fronting on the Indian Ocean, extending inland to Lake Tanganyika and covering about 10 degrees of latitude. They have also on the west coast what is known as German Southwest Africa, covering about 9 degrees of latitude; in all

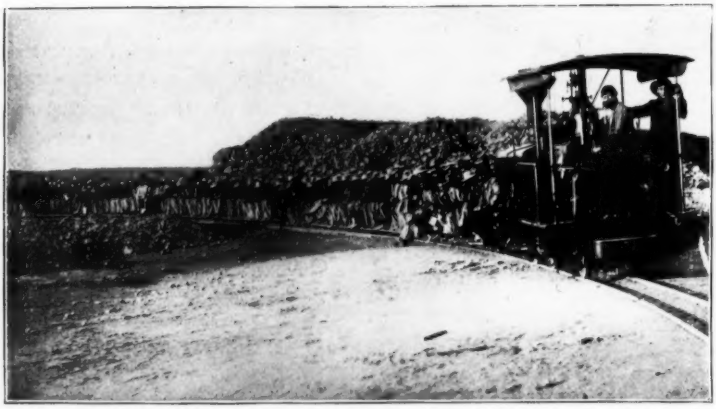
925,000 square miles. The French claim the Western Sahara, certain territory on the Mediterranean, and the valley of the Senegal and the upper part of the Niger. The Portuguese claim, besides Portuguese East Africa, a territory on the west coast known as Angola. Italy has a precarious holding on the Red Sea and the Indian Ocean, and Spain has a little more than 200,000 square miles in the northwest. According to Mr. Scott-Keltie, Secretary of the Royal Geographical Society, the holdings in square miles of the various European Powers are as follows:

France	3,300,000
Great Britain	2,300,000
Germany	925,000
Congo Free State	900,000
Portugal	750,000
Italy	420,000
Spain	214,000
Boer Republics	168,000

This leaves about 2,900,000 square miles occupied by negroes and Arabs. But to England's holdings we should add Egypt and the

THE MORNING MARKET, KIMBERLEY.

Egyptian Soudan and the Boer Republics; so that England is, by all odds, the greatest land-holder in Africa, although in Mr. Scott-Keltie's table France appears as such. If one will look at a good map, how-



SOUTH AFRICAN LOCAL TRANSPORT. STEAM TRAM AT THE DE BEERS MINES.

ever, he will see that as Lord Salisbury said, the French African territory is mostly very light soil. England's holdings cover all that is best in Africa, except a little strip along the Mediterranean and possibly German Southwest Africa.

These empires into which the Powers have divided the Continent

ZULU HUTS AT THE KIMBERLEY DIAMOND MINES.

of Africa are mostly inaccessible for commerce or industry. The cost in time and money and the danger to life are too great for anyone to go into them, except for war, or sport, or religion; and before we speak of the possible future of Africa we should consider how we are to get there.

The Cape-to-Cairo Railroad is a good deal in the public mind and is much talked of in a taken-for-granted way, and it would be well to speak of that first, especially as a discussion of this project brings out the natural line of attack on the Continent. Henry Stanley, writing a few months ago, said: "The Cape-to-Cairo Railway,

RICKSHAW STAND, DURBAN, NATAL.

which some appear to think is improbable, will be an accomplished fact before 1925, I believe." Now I do not believe it will, nor do I believe that Cecil Rhodes himself believes it will, nor do I believe that Cecil Rhodes has any notion of building a continuous line of railroad from the Cape to Cairo. It is inconceivable that he should be so injudicious. The total line would be about 5,600 miles, as well as we can tell by scaling off the distances on the best maps. Accurate measurements have been made of about two-fifths of this distance—from Alexandria to Khartoum and from Cape Town to Bulawayo. The intervening distance, about 3,300 miles, has been roughly meas-

ured by the itineraries of travelers, but these are only coarse approximations. From Cape Town to Bulawayo is 1,360 miles, and here a railroad is built already. From Bulawayo north to the Zambezi River is perhaps 300 or 350 miles, and Mr. Rhodes has already financed this extension. Very likely it will be built at once after the war ends. From the Zambezi to the south end of Lake Tanganyika

THE CASTLE HOTEL, HOWICK, NATAL.

is 450 or 500 miles. The lake itself is about 400 miles long; then there is about 300 miles to the Albert Nyanza by land; then something like 200 miles of navigable water the length of the Albert Nyanza and in the upper part of the Nile as far as Dufli; then there is about 125 miles of rapids and obstructed river; then 1,000 miles of river from Lado in the fifth degree of north latitude to Khartoum, and then we come to the Sirdar's military railroad. If we want a through line of steam communication overland from the Mediterranean to the Cape of Good Hope, we could save about 1,600 miles of railroad by using the Nile and the lakes. We should save, not only the interest on the cost of building this 1,600 miles of railroad, but a large part of the cost of maintenance and of operation.

The reasons for building a railroad along this 1,600 miles of waterway would be the gain of time and the avoidance of transship-

HOWICK WATERFALL, 308 FT. SHEER DROP.
Just north of Pietermaritzburg, Natal.

ment of freight. If we used a combined rail and water way, we should be obliged to transfer from rail to boat, or boat to rail, at Khartoum, at Lado, at Dufli, at the south end of the Albert Nyanza, at the north end of Tanganyika and at the south end of Tanganyika, namely, six times. But why not? The through traffic carried over such a route could be only the very small amount of costly commodities able to stand the freight rate which it would be necessary to

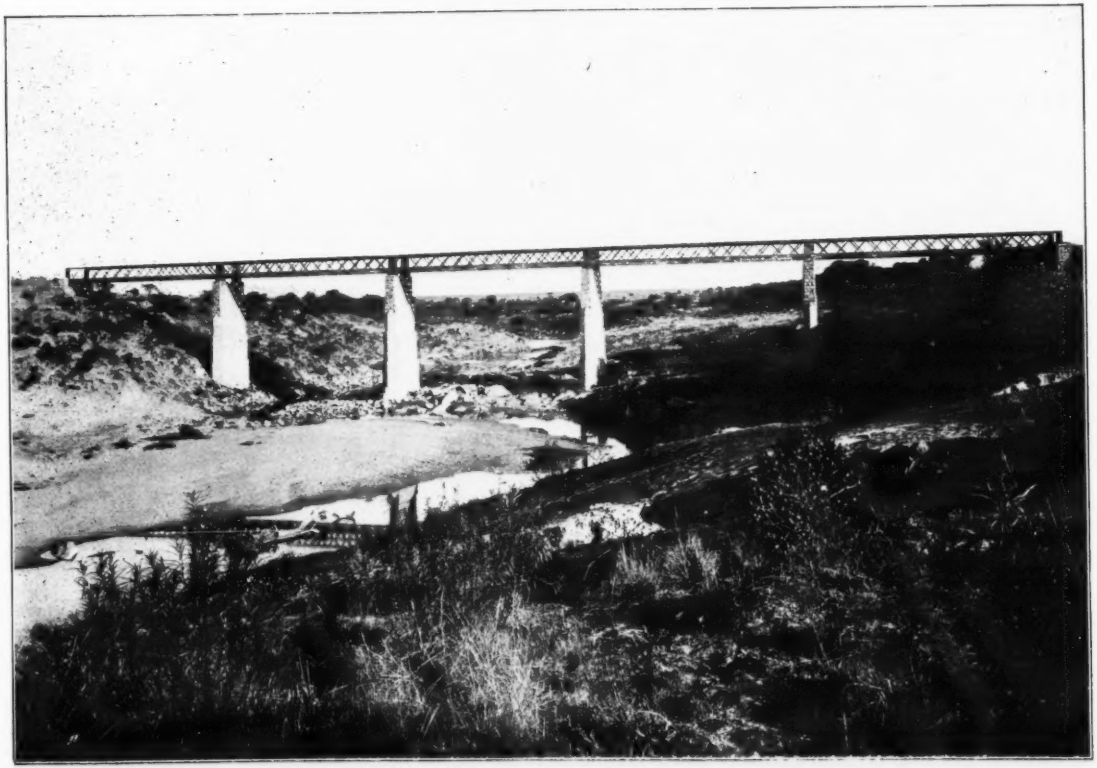
charge. Some gold might go this way, some diamonds, a little ivory, and a few ostrich feathers, although it is hard to see why even these commodities should not seek the nearest seaport. No staples could pay the cost of through carriage by this route so long as the oceans exist.

This through line, whether all rail or river and rail, must compete with the Red Sea and the Indian Ocean on one side and the Atlantic on the other. The local traffic would be only such as would come from the production and the needs of a thin population of savages and from the small needs of the military posts. It is possible to imagine a freight movement equal to one freight car a day over any

COACH CROSSING THE CROCODILE RIVER, PRETORIA, ON THE BULAWAYO ROAD.
The road crosses the river, called also the Limpopo, at Rhodes' Drift.

part of the line between Khartoum and the Zambezi, or about 2,500 miles; it is difficult to imagine more than this.

The obvious method of attacking all of East Africa is from the Red Sea and the Indian Ocean by building in spurs of railroad. For instance, a railroad will no doubt be built within a few years from Suakim, on the Red Sea, over to the Nile, about 240 miles, by the shortest route—or perhaps 275 to Khartoum. Some day a short railroad may be built from Massaua into Abyssinia and another one from a port of British Somaliland. A railroad is now actually building from Mombasa through British East Africa to the Victoria Lake. Probably the Germans will push in a railroad sometime from near



RAILWAY BRIDGE OVER THE VALSCH RIVER. KROONSTAD, ORANGE FREE STATE.

The Grand Hotel.

Agency Chambers.
Imperial Buildings.

The Band Stand.

GLIMPSES OF BULAWAYO, MATABELELAND.

Zanzibar. There is already a short railroad from Beira, in Portuguese East Africa, and that will doubtless be extended to Salisbury in Rhodesia. There is a railroad from Delagoa Bay to Pretoria, and several others have already been built in from various ports on the British South African coast. Such, then, is the obvious development of the attack on Africa all the way from Alexandria to Cape Town.

On the west coast the situation is less obvious. In the northwest there is a vast region in which the French talk of building railroads, but which is really not worth occupation. But as we go southward there are various points of attack by short lines run in from the ocean when the time comes.

A FLEET OF HOUSE CANOES AT ISANGI, ON THE CONGO.

My proposition, in general, is that the economical and efficient way of opening this continent is by short lines from bases on the coast, and this proposition seems so obvious that it is hardly worth while to discuss it. Unfortunately, Africa is singularly lacking in good natural harbors; yet there are enough harbors, and good ones enough, for her needs for some generations to come. Further, the attack of a barbarous and even savage continent, thinly peopled and most unhealthful, by long transcontinental railroads, either north or south, or east and west, is not merely unscientific, but visionary.

But is the continent worth conquest and occupation by white

men? Unquestionably, parts of it are. As the years go by and the world becomes more crowded, parts of Africa now not worth occupation will be valuable, and even to-day considerable areas are worth the white man's while. These are already mostly under British control. Mr. Stead has said, "everything in Africa that pays dividends lies within the sphere pegged out for John Bull by his adventurous sons. Wherever in Africa you find land in which white-skinned children can be bred and reared, you will find it lies within the British zone. All of Africa that is habitable, and all of Africa that pays its

A RIVERSIDE TOWN ON THE CONGO.

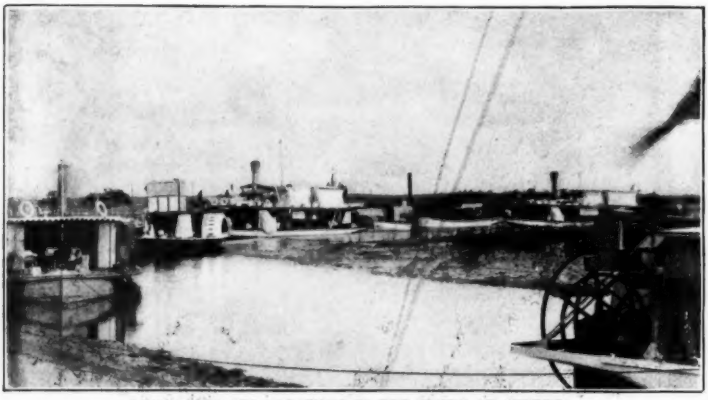
way, is British Africa." With but very little modification this is correct.

Lower Egypt is a garden. Mr. Penfield, lately U. S. Consul General in Egypt, says that its population is 928 per square mile and that it has increased 44½ per cent. since the British control began in 1884. The Soudan, now opening up by the energy of Englishmen, will supply a small population living from the soil, but can never be a manufacturing country, for it has no fuel and probably no important deposits of minerals. There is gold up the Blue Nile which may, perhaps, be worth working on a small scale. A little

AN INLET ON THE WEST COAST OF LAKE NYASSA.

THE WEST COAST OF LAKE NYASSA, BETWEEN NKATA AND DEEP BAY.

The view shows the mountainous country characterizing this coast, with the many coves and bays. The A. T. T. Company's telegraph line runs along this coast.

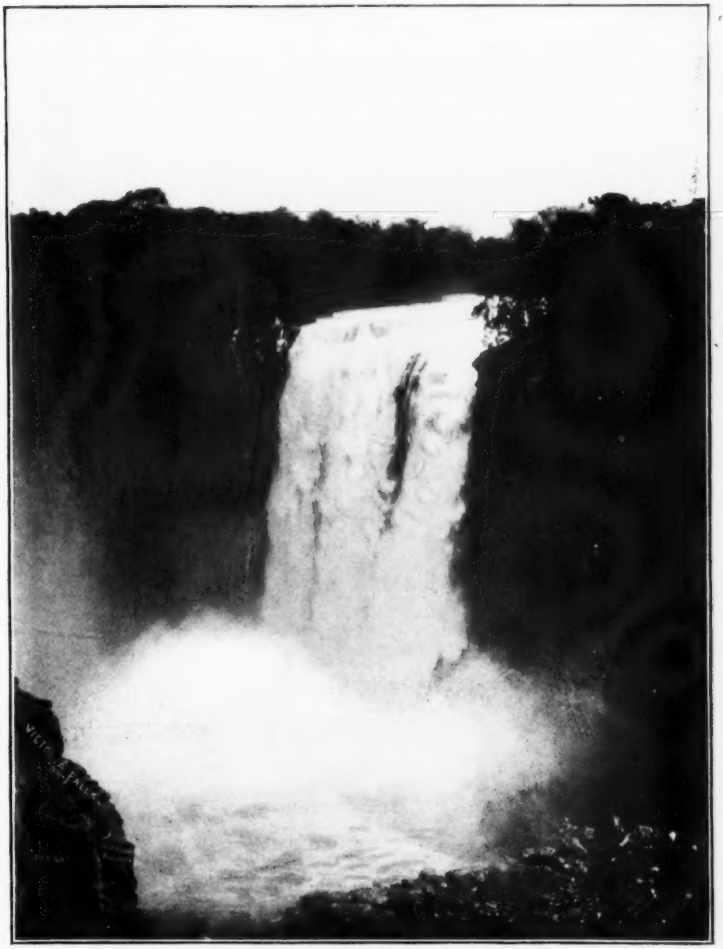


GUNBOATS AND STEAMERS IN THE CREEK AT CHINDE.
Chinde is at the nofthernmost mouth of the Zambezi delta.

trade will again be developed in gum arabic, and in ostrich feathers and ivory coming down from the South, and the people will require some of the products of civilization. But, on the whole, I do not estimate that this country will pay the cost of good government for years to come. It will be a burden on its rulers rather than a source of revenue. This always was Gordon's opinion.

South of the Soudan, all the way from the tenth degree of north latitude to the Zambezi, say to about latitude 17 south, is a country of savages, mostly naked. It is a country of malarial fevers and

H. M. S. MOSQUITO, IN THE ZAMBEZI RIVER.



VICTORIA FALLS, ON THE ZAMBEZI RIVER.

apparently with no coal, iron, gold, or silver worth developing, although it would be foolish to say that valuable gold deposits may not be found. People talk of fine woods and gums and spices. The ebony is sparse in quantity and small in size. I never saw there a stick over six inches through, and seldom so large, and that means about three inches of black wood. It would not be worth shipping out, nor

A BIT OF AFRICAN JUNGLE NEAR VICTORIA FALLS.

can I imagine that any other timber would be found that would bear transportation to the sea in competition with countries that have harbors, navigable streams, railroads, and a climate in which white men can live. It does not seem as if spices or gums could be the basis of a large trade and of a civilization. In 1897, Zanzibar exported cloves to the value of about $450,000, ivory about $640,000 and gums about $330,000. This was the product of a great region which had concentrated at Zanzibar, and probably this trade may be considerably increased with cheaper transportation.

After we get south of the Zambezi, and from there to the Cape, we find a country really important, and at this moment of surpassing interest. Here there are great areas in which white men can live, and smaller areas almost without malarial fevers. There are alsc great areas in which the fevers are serious. In this country, as we know, lie gold mines, some of them of vast importance. Something like $75,000,000 a year in gold is taken out of the Transvaal mines. It is estimated that this product may be increased to more than $100,-

THE ZAMBEZI RIVER, TWO MILES BELOW THE FALLS.

GOODWIN LEAVING BOPOTO, ON THE CONGO, TO FOUND A MISSION AT YAKUSU.

000,000, with good government.* In the country to the north, now known as Rhodesia, there are mines, the importance of which is still to be demonstrated. Opinions differ widely among those who know the country best, but there can be little doubt that there are gold deposits in Rhodesia which will be well worth working when peace comes again and railroad transportation is developed. The railroad is now built through from the Cape to Bulawayo, 1,360 miles, and Mr. Rhodes will probably carry it on to the Zambezi, while it seems inevitable that a much shorter haul to the sea should soon be established by building a railroad from Beira to Salisbury, say 350 miles.

In all this vast area from the Zambezi to the Cape, covering 18 degrees of latitude, there is necessarily considerable diversity of soil, topography, and climate; but we may say, speaking generally, that much of it is well suited to agriculture, much of it is too arid for agriculture, and a great deal of it is valuable for ranching and grazing. Agriculture, ranching, and grazing will naturally depend a good deal upon the local markets furnished by the mines, and in many regions

*John Hays Hammond, in his latest official report, which he amplified in the preceding issue of this Magazine, stated that the output would have exceeded £20,000,000 in 1899, had there been no interruption of mining. Dr. Hatch, formerly Mr. Hammond's assistant, writing in THE ENGINEERING MAGAZINE for August, 1899, estimated that within five years the gold production of the Witwatersrand mines would reach the enormous figure of £36,000,000—nearly $180,000,000—per annum. THE EDITORS.

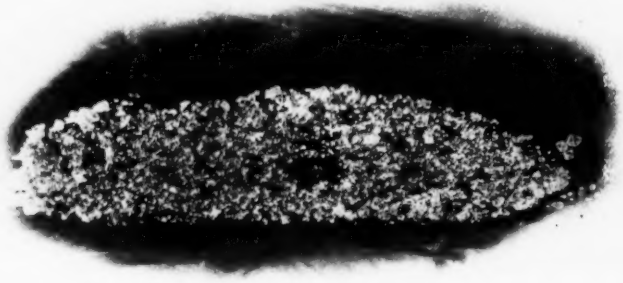
these are important and will be more so. These industries will also furnish some export trade, and in turn will create import trade. It is not estimated that the country can be valuable for manufacturers. Considerable coal has been developed, but the quality is not good. Labor is of a low grade and dear; there is practically no dependable water power; there are no navigable streams, and timber is very scarce. Considering all these things, and considering the heat, the droughts, and the malarial fevers, which will lower the white man's productive energy in vast regions of the country, we are not justified in thinking that the conquest of the southern part of Africa is to open up anything comparable in value to the world with any like area in North America. We are justified, however, in believing that the moment the war closes and the security and liberty of British rule are established, an important trade will again go on. This trade will be especially important to those who are making engineering products. Mining machinery must be purchased. Railroads must be extended and, as a consequence, bridge material and machinery for railroads and shops must be bought. Naturally, considerable electrical machinery will go into the country, for the most primitive civilization now involves electricity. Within a few months an engineer has

NATIVES ON THE ZAMBEZI RIVER.

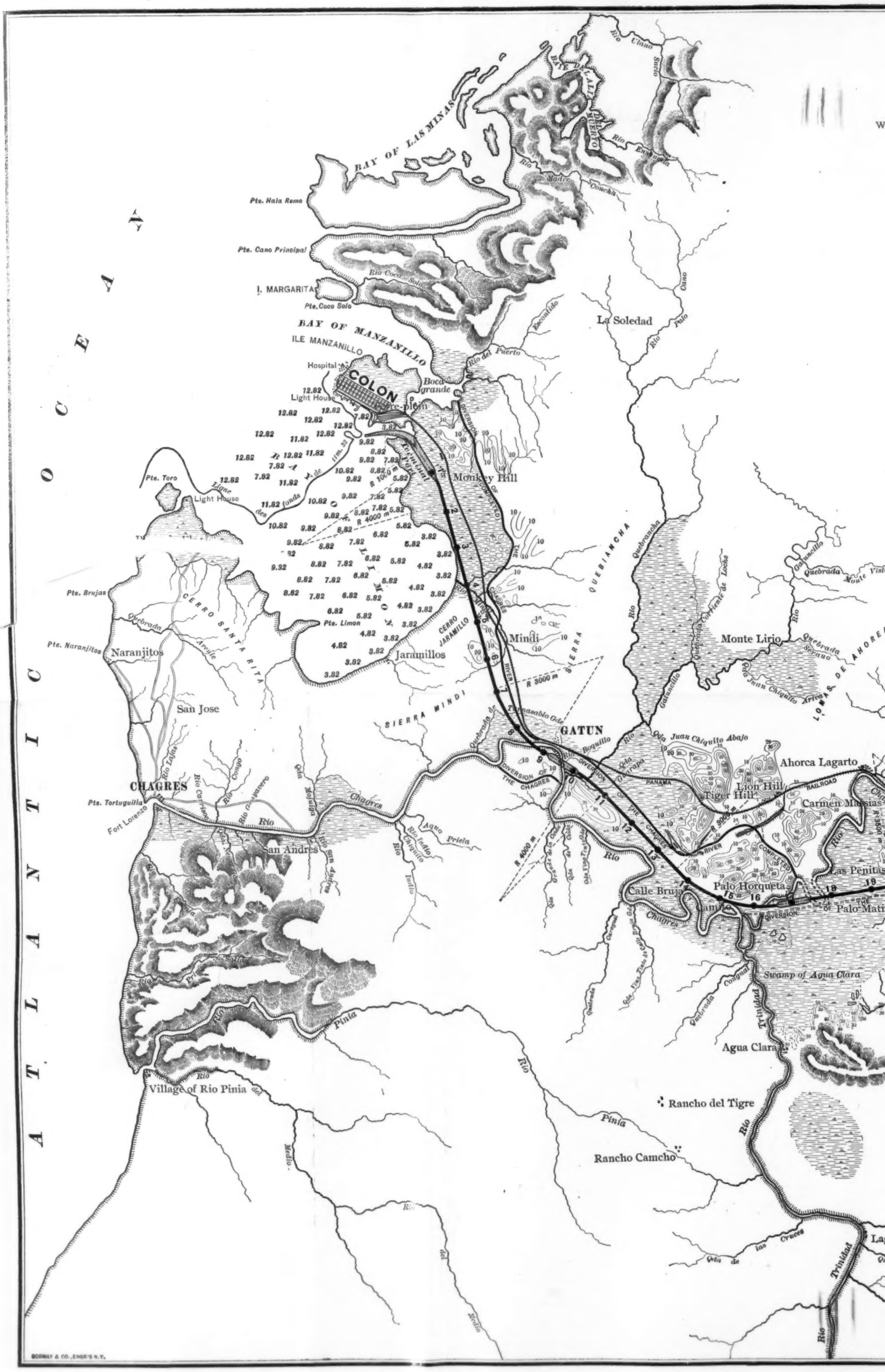
visited the United States in the interest of the Chartered Company to look into the art of developing and transmitting power with the aid of electricity. It seems to be believed that some small water powers may be developed in the country and utilized by long-distance transmission.

Concerning all the rest of Africa Mr. Stead is about right. In John Bull's holdings along the Cape-to-Cairo line is included nearly all that is dividend paying. German East Africa, German South Africa, Portuguese Angola, the Congo Free State and the British Niger territories are great savage countries, so fever stricken that no white man who can get a living elsewhere is justified in going there to live, although with some of those countries there is now a valuable trade. A few adventurous men who love to fight, organize, and rule can hold these lands and help the negroes to slow development into producers and consumers, but the process will be tedious and costly in human energy. I remember reading years ago a sentence or two written by David Livingstone, the truth of which was painfully obvious to me at the time. He said, in effect, that for any white man merely to live in Africa was a great achievement—that we must not expect from him very much in the way of moral, or intellectual, or physical energy.

For the illustrations accompanying this article, THE ENGINEERING MAGAZINE is indebted to the courtesy of the British South Africa Company and of Mr. Irwin.



A DAY'S DIAMOND WASH, KIMBERLEY.


ATLANTIC OCEAN
BAY OF LIMAS
BAY OF MANZANILLO
ILE MANZANILLO
I. MARGARITA
Pte. Hala Remo
Pte. Cano Principal
Pte. Coco Solo
Hospital
COLON
Light House
Pte. Toro
Pte. Brujas
Pte. Naranjitos
Naranjitos
San Jose
CERRO SANTA RITA
CHAGRES
Pts. Tortuguilla
Fort Lorenzo
San Andres
Village of Rio Pinia
Rio Pinia
Rancho del Tigre
Rancho Camcho
Monkey Hill
Pte. Limon
Jaramillos
CERRO JARAMILLO
Mindi
SIERRA MINDI
GATUN
Gatun Lake
Ahorca Lagarto
Lion Hill
Tiger Hill
Carmen Massias
Las Penitas
Palo Horqueta
Calle Bruja
Swamp of Agua Clara
Agua Clara
La Soledad
Monte Lirio
QUEBIANCHA
Rio Chagres
Rio Pinia
Rio Trinidad
Rio Indio
Rio Agua Priela
Rio Escandido
Rio Puerto
Rio Madre Conchi
Rio Boquillo
Rio Juan Chiquito Abajo
Rio Juan Chiquito Arriba
Rio Quebrancha
Rio Calanchillo
Rio Monte Viejo
Rio Peluo
Rio Oano
Rio Medio
Rio Trinidad
Quebrada Arroyo
Quebrada Cortiente de Locha
Quebrada Bejuco
Quebrada Monte Viejo
Quebrada de los Cruces
Quda Juan Chiquito Abajo
Quda Juan Chiquito Arriba
Quda Trinidad
Quda Tres Tacos de Leche
Quda Carmen
Quda Cruces
Quda Gatun
Quda Mindi
Quda Gigante
Quda Gatun
Quda Mindi
Quda Gigante
Quda Trinidad
Quda Tres Tacos de Leche
Quda Carmen
Quda Cruces

GENERAL PLAN
OF THE
PANAMA CANAL

WITH DETAILS OF THE PROJECT BASED UPON A SUMMIT LEVEL OF 20.75 METRES

REENGRAVED FROM THE ORIGINAL

FOR

THE ENGINEERING MAGAZINE. vol. 18, no. 5 (Feb. 1900)

SCALE: $\frac{1}{100,000}$

0 5 1K 2K 3K

LEGEND

- Line of the Canal.
- Diversions completed.
- Diversions uncompleted.
- Line of the Panama Rail Road.
- Deviation of the Panama Rail Road.
- Feeding ditches.
- Railroad from Gamboa to Alhajuela.
- Line of Soundings of 11.32 metres
- Buildings belonging to the Company.
- Buildings belonging to individuals.

NOTE: Altitudes are expressed in Metres above the mean level of the two oceans.

Soundings are refered to the mean level of the two oceans.

Position of the Panama Cathedral 8° 57' 16" Lat. N., 81° 51' 0" Long. W. of the meridian of Paris.

GENERAL LIBRARY,
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Barrage
ALHAJUELA
Gatun
Cupe
Las Delicias
Juan Mina
Pihiva
Palo Grande
Cruces
Gamboa
Locks of Obispo
OBISPO
MATACHIN
Las Cascadas
GORGONA
Juan Grande
Culebra
Frijoles
Mamei
BOHIO SOLDADO
Chagres
Santana
Vamos Vamos
Peña Blanca
Matias
Chagrecito
SAN PABLO
TAVERNILLA
Lagartera
Quebrada
Largatera
Rio Chagres
Rio Grande
Rio Piso
Rio Obispo
Rio Bohio
Rio Tortuoso
Rio Frijoles
Rio Gigante
Rio Guayabito
Rio Caimito
Rio Pajo
Rio Mula
Rio Pescados
Rio Trinidad
Rio Mamei
Rio Bait
Rio Monita
Rio Eugenia
Rio Cascadas
Rio Chilibrillo
Rio Agua Bautista
Rio Cabilla
Rio Tavernilla
Rio Juan Grande
Rio Culebra
Rio Marias
Rio Marta
Rio Marsella
Rio Paraiso
Rio Caño Quebrado
Rio Caño Barranco
Rio Caño Quemado
Rio Caño Negro
Rio Caño Seco
Rio Caño Blanco
Rio Caño Bermudez

GOODWIN LEAVING BOPOTO, ON THE CONGO, TO FOUND A MISSION AT YAKUSU.

000,000, with good government.* In the country to the north, now known as Rhodesia, there are mines, the importance of which is still to be demonstrated. Opinions differ widely among those who know the country best, but there can be little doubt that there are gold deposits in Rhodesia which will be well worth working when peace comes again and railroad transportation is developed. The railroad is now built through from the Cape to Bulawayo, 1,360 miles, and Mr. Rhodes will probably carry it on to the Zambezi, while it seems inevitable that a much shorter haul to the sea should soon be established by building a railroad from Beira to Salisbury, say 350 miles.

In all this vast area from the Zambezi to the Cape, covering 18 degrees of latitude, there is necessarily considerable diversity of soil, topography, and climate; but we may say, speaking generally, that much of it is well suited to agriculture, much of it is too arid for agriculture, and a great deal of it is valuable for ranching and grazing. Agriculture, ranching, and grazing will naturally depend a good deal upon the local markets furnished by the mines, and in many regions

*John Hays Hammond, in his latest official report, which he amplified in the preceding issue of this Magazine, stated that the output would have exceeded £20,000,000 in 1899, had there been no interruption of mining. Dr. Hatch, formerly Mr. Hammond's assistant, writing in THE ENGINEERING MAGAZINE for August, 1899, estimated that within five years the gold production of the Witwatersrand mines would reach the enormous figure of £36,000,000—nearly $180,000,000—per annum. THE EDITORS.

these are important and will be more so. These industries will also furnish some export trade, and in turn will create import trade. It is not estimated that the country can be valuable for manufacturers. Considerable coal has been developed, but the quality is not good. Labor is of a low grade and dear; there is practically no dependable water power; there are no navigable streams, and timber is very scarce. Considering all these things, and considering the heat, the droughts, and the malarial fevers, which will lower the white man's productive energy in vast regions of the country, we are not justified in thinking that the conquest of the southern part of Africa is to open up anything comparable in value to the world with any like area in North America. We are justified, however, in believing that the moment the war closes and the security and liberty of British rule are established, an important trade will again go on. This trade will be especially important to those who are making engineering products. Mining machinery must be purchased. Railroads must be extended and, as a consequence, bridge material and machinery for railroads and shops must be bought. Naturally, considerable electrical machinery will go into the country, for the most primitive civilization now involves electricity. Within a few months an engineer has

NATIVES ON THE ZAMBEZI RIVER.

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GENERAL PLAN

OF THE

PANAMA CANAL

Re-engraved from the Original

SUPPLEMENT TO

THE ENGINEERING MAGAZINE

FEBRUARY, 1900.
(vol. 18, no. 5)

TO ACCOMPANY THE ARTICLE BY

CHARLES PAINE

P

WITH DETAILS OF THE

REE

NOTE:

Position

BAY OF LAS MINAS

Pte. Hala Remo

Pte. Cano Principal

I. MARGARITA

Pte. Coco Solo

BAY OF MANZANILLO

ILE MANZANILLO

Hospital

COLON

Light House

Boca grande

Entre-ploin

Monkey Hill

Pte. Toro

Light House

Playa de Pio.

Pte. Brujas

Pte. Naranjitos

Naranjitos

San Jose

CHAGRES

Pte. Tortuguilla

Fort Lorenzo

San Andres

Village of Rio Pinia

Rancho del Tigre

Rancho Camcho

La Soledad

Rio del Puerto

Escudido

Rio Coco Solo

Rio Madre

Concha

Rio Ulano

Rio Estero

Rio Tuio

Canio

Quebrancha

QUEBIANCHA

Gatuncillo

Quebrada Monte Vistoso

Monte Lirio

Quebrada Serrano

Quebrada Corriente de Leche

LOMAS DE AHOREA LAGARTO

Cuipeque

Rio Juan Chiquito Arriba

Juan Chiquito Abajo

Mindi

Jaramillos

CERRO JARAMILLO

CERRO SANTA RITA

SIERRA MINDI

SIERRA MINDI

Tranasable Gde

GATUN

Boquillo

Ahorca Lagarto

Lion Hill

Tiger Hill

Carmen Macias

Vamos Vamos

Las Penitas

Palo Horqueta

Calle Bruja

Palo Matias

Swamp of Agua Clara

Agua Clara

Lagartera

BORIO SOLDADO

Santana

Rio Tortuoso

Swamp of Pena

Locks of Bo

RAILROAD

PANAMA

DIVERSION OF THE CHAGRES

CHAGRES DIVERSION

COMPLETED

Rio Chagres

Agua Priela

Rio Indio

Rio Pinia

Rio Mello

Rio Trinidad

Rio Lajas

Rio Congo

Rio Caribano

Rio Caribanito

Rio Sabanero

Rio San Andres

Quebrada

Arroyo

Qda Juan Diaz

Qda Tres Ranchos

Qda Fondo de Cruces

Qda de las Cruces

Qda Tres Pinto de Calle Bruja

Qda Quebrada

Qda Conjunal

Qda Cabila

Qda Cabilla

Qda Cabillo

Qda Mogollon

Qda Caribano

Qda Caribanito

Qda Congo

Qda Sabanero

Qda Lajas

Qda Tortuguilla

Qda Naranjitos

Qda Brujas

Qda Pto. Toro

Qda Pto. Hala Remo

Qda Pto. Cano Principal

Qda Pto. Coco Solo

Qda Pto. Limon

Qda Pto. Naranjitos

Qda Pto. Brujas

Qda Pto. Toro

Qda Pto. Tortuguilla

Qda Pto. Naranjitos

Qda Pto.

GENERAL PLAN
OF THE
PANAMA CANAL

THE PROJECT BASED UPON A SUMMIT LEVEL OF 20.75 METRES

REENGRAVED FROM THE ORIGINAL

FOR

THE ENGINEERING MAGAZINE. vol. 18, no. 5 (Feb. 1899)

SCALE: $\frac{1}{100,000}$

0 1K 2K 5K

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- Diversions uncompleted.
- Line of the Panama Rail Road.
- Deviation of the Panama Rail Road.
- Feeding ditches.
- Railroad from Gamboa to Alhajuela.
- Line of Soundings of 11.32 metres
- Buildings belonging to the Company.
- Buildings belonging to individuals.

NOTE: Altitudes are expressed in Metres above the mean level of the two oceans.

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Position of the Panama Cathedral 8° 57' 16" Lat. N., 81° 51' 01" Long. W. of the meridian of Paris.

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Gamboa
Locks of Obispo
OBISPO
MATACHIN
GORGONA
Juan Grande
Las Cascadas
EMPERADOR
Frijoles
Mamei
Chagrecito
SAN PABLO
TAVERNILLA
Pena Blanca
Cerro Tavernilla 220m
La pierre Sin Cabeza
Cerro Maquinal 215m
Cerro Agua Fria 290m
Cerro Rico 190m
Cerro de Las Minas
Quartz Gold Mine
Rio Chagres
Rio Obispo
Rio Grande
Rio Trinidad
Rio Caimito
Rio Gigante
Rio Guayabito
Rio Pena Blanca
Rio Frijoles
Rio Boqueron
Rio Mamei
Rio Pequeni
Rio Caño Quebrado
Rio Peascado
Rio Pena
Rio Caño
Rio Gamito
Rio Marias
Rio Azules
Rio Largaterita
Rio Quebrada
Rio Agua Bendita
Rio Eugenia
Rio Cabalito
Rio Tavernilla
Rio Calabrito
Rio Caimito
Rio Cano

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WITH DETAILS OF THE PROJ

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Naranjitos

San Jose

CHAGRES

Pte. Tortuguilla

Fort Lorenzo

San Andres

Pte. Limon

Jaramillos

CERRO JARAMILLO

Mindi

SIERRA MINDI

Monkey Hill

DIVERSION OF THE CHAGRES

CONTINUATION OF THE CHAGRES

COMPLETED

GATUN

RIVER

R 3000 m

R 4000 m

La Soledad

QUEBRANCHA

Monte Lirio

LOMAS DE AHORCA LAGARTO

Ahorca Lagarto

Lion Hill

Tiger Hill

Carmen Mansias

BORIO SOLDADO

Santana

Vamos Vamos

Las Penitas

Palo Horqueta

Calle Bruja

Palo-Matias

Swamp of Agua Clara

Agua Clara

Rancho del Tigre

Rancho Camcho

Village of Rio Pinia

Lagartera

Rio Chagres

Rio Pinia

Rio Trinidad

Rio Medio

Rio Tortuoso

Locks of Bohio

BORMAY & CO., ENGR'S N.Y.

GENERAL PLAN
OF THE
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PROJECT BASED UPON A SUMMIT LEVEL OF 20.75 METRES

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OBISPO
MATACHIN
GORGONA
Juan Grande
Las Cascadas
EMPERADOR
CULEBRA
Frijoles
Mamei
Chagres
Chagrecito
SAN PABLO
TAVERNILLA
Cerro Blanca
Cerro Tavernilla 220m
La pierre Sin Cabeza
Cerro Maquinal 215m
Cerro Agua Fria 290m
Cerro Rico 190m
Cerro de Las Minas
Quartz Gold Mine
Largatetta
Rio Chagres
Rio Obispo
Rio Gigante
Rio Guayabito
Rio Caño
Rio Pajaro
Rio Frijoles
Rio Trinidad
Rio Boqueron
Rio Peñoso
Rio Calabrito
Rio Agua Brujita
Rio Eugenia
Rio Cabrillo
Rio Tavernilla
Rio Juan Mina
Rio Pilon
Rio Agua Clara
Rio Grande
Rio Aguacate
Rio Agua Fria
Rio Cascajal
Rio Matachin
Rio Culebra
Rio Mamei
Rio Baile
Rio Merinosa
Rio Caratuel
Rio Pescado
Rio Piro
Rio Agua Salud
Rio Aguas
Rio Trinidad
Rio Boqueron
Rio Peñoso
Rio Calabrito
Rio Agua Brujita
Rio Eugenia
Rio Cabrillo
Rio Tavernilla
Rio Juan Mina
Rio Pilon
Rio Agua Clara
Rio Grande
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Rio Agua Fria
Rio Cascajal
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Rio Piro
Rio Agua Salud
Rio Aguas
Qda Grande
Qda Contadora
Qda Falupa
Qda Falupita
Qda Dos Hermanas
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Qda Pescado
Qda Piro
Qda Agua Salud
Qda Aguas
Chagres River Diversion
Feeding Ditches
Panama Railroad
Panama Railroad Diversion of Chagres
R. 3000m
R. 2500m

ENERAL PLAN
OF THE
AMA CANAL

BASED UPON A SUMMIT LEVEL OF 20.75 METRES

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FOR

NGINEERING MAGAZINE. vol. 18, no. 5 (Feb. 1899)

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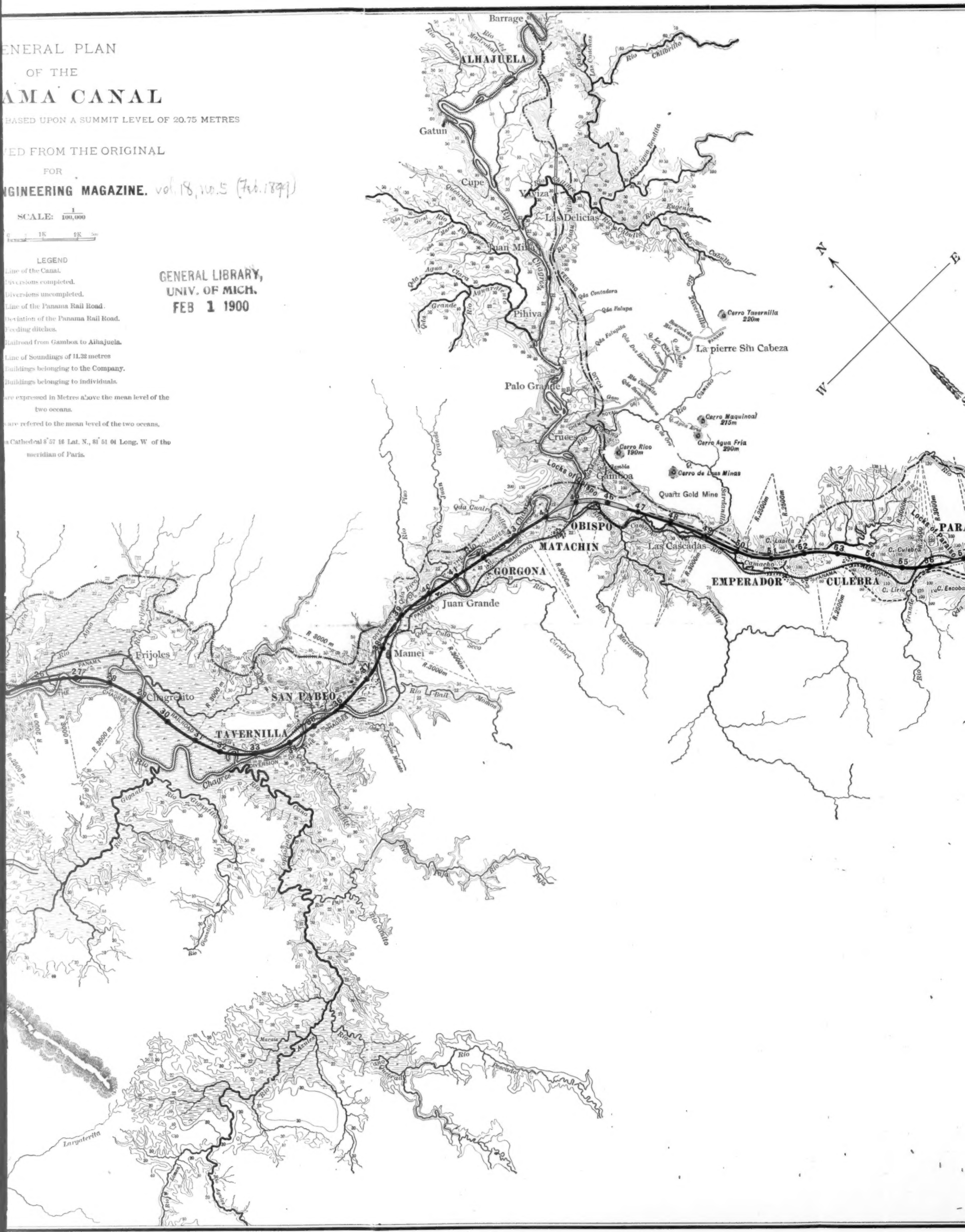
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PARA
C. Lapita
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Rio Largaterita
Rio Pacora
Rio Martinez
Rio Mindi
Rio Agua Buena
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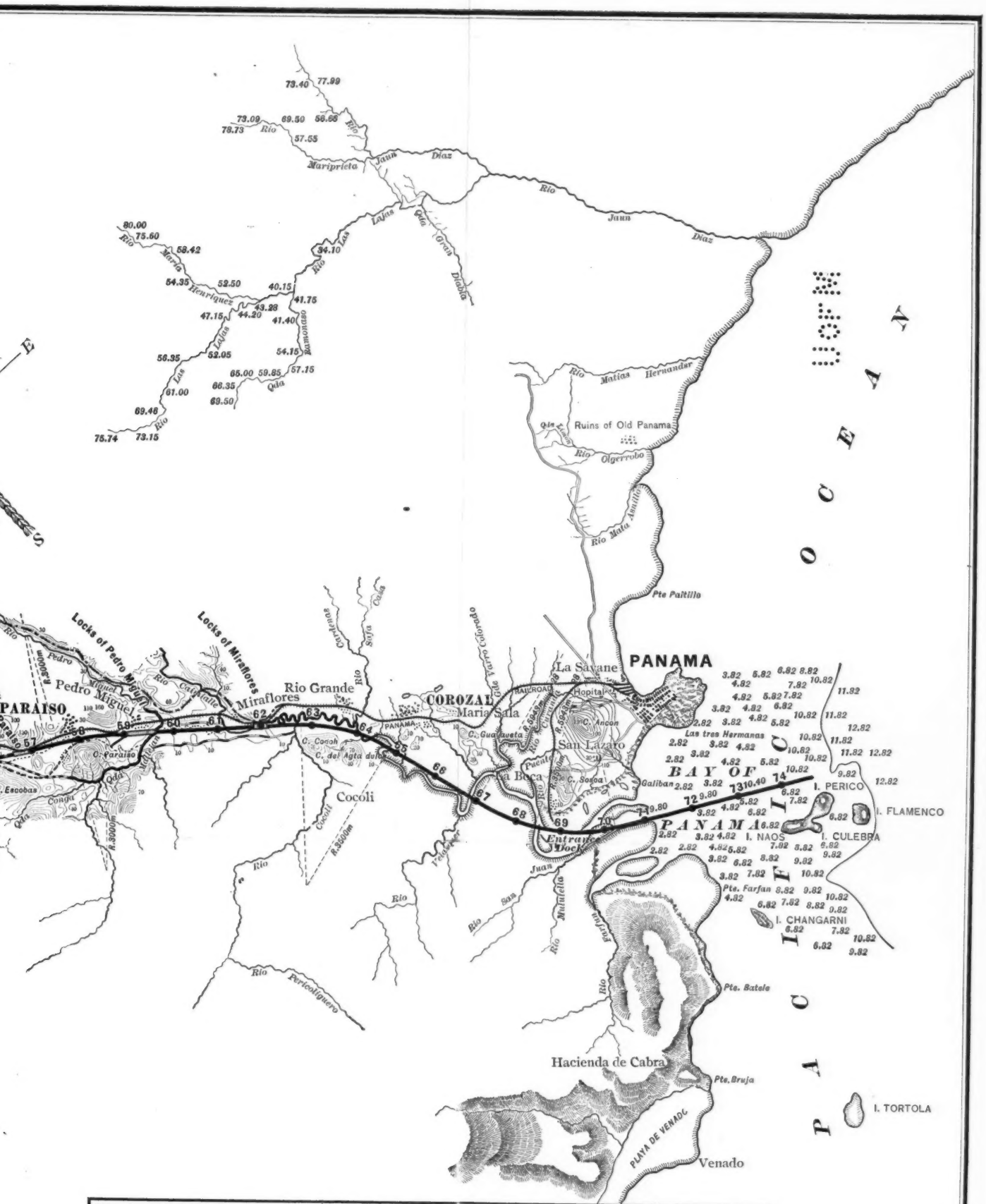
Rio Quebrada Ancha
Rio Quebrada Seca
Rio Quebrada Mina
Rio Quebrada Obscura

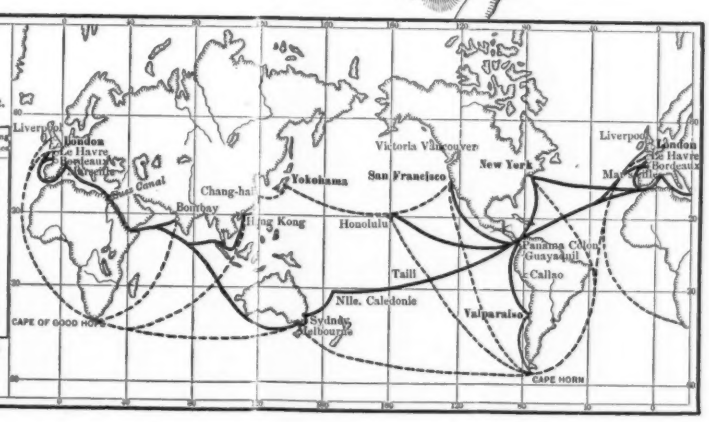


Shortening of the Principal Sailing Distances.

Distances are given in Nautical Miles of 6,080 ft.

	Via Cape Horn	Via the Canal	Shortening of Distance
Plymouth to San Francisco	13,491	7.775	5.716
Plymouth to Honolulu	13,671	9.196	4.475
Plymouth to Valparaiso	9,737	7.981	1.856
Plymouth to Callao	9,990	5.910	4.144
Plymouth to Victoria Van.	14,270	8.492	5.716
New York to Valparaiso	8,540	4.854	4,014
New York to Panama	11,057	1.926	9,131
New York to Callao	8,791	2,263	6,528
New York to Guayaquil	10,441	2,768	7,673
New York to San Francisco	13,324	5,228	8,096

NOTE: Taken from the table of distances published by the French government for the administration of the law of Jan. 20, 1881 granting bounties to the Merchant Marine.



CONCERNING THE ACTUAL CONDITION OF THE PANAMA CANAL.

By Charles Paine.

THESE are the facts as they appear to me, after a stay of three weeks on the Isthmus, during which I was able to see substantially the whole line of the canal, from the Island of Naos in the Bay of Panama, where the excavations for a channel begin, through to Christophe Colombe, where the interior harbor has been constructed, connecting with the Atlantic Ocean.

I sailed in a small steamer from Naos up to the mouth of the Rio Grande, where the Panama Rail Road has built a fine modern iron pier 1,000 feet long, roofed and equipped with rapid transporters, and with a connecting basin adjacent to the canal deep enough for the accommodation of such steamships as run to Panama. The channel from Naos to La Boca, as the locality of this pier is called, is 300 feet wide, perfectly straight, and marked at frequent intervals at each side with buoys intended to be lighted at night. The old piers in Panama cannot be approached by any but the smallest craft even at mid-tide, and are high and dry at low tide; hence, it was a clear necessity for the improvement of commerce to provide the La Boca wharf, which is accessible at all stages of water. So the canal may be regarded as nearly completed up to La Boca; above there it has been once completed for a distance of some miles, but has now become considerably obstructed by sediment brought down by the streams which empty into it or into the Rio Grande. The canal appears upon the surface to be of its original dimensions and impresses the visitor just as it will after the deposits shall have been removed. Everywhere, through the portions of the canal which have once been finished, the banks have retained their integrity, and the canal still looks to be in first-rate condition—only the sounding line reveals the sedimentation. I judge that the reason for this is the very rapid growth of vegetation which has covered the banks with a close thicket down to the water's edge.

From Bohio, at kilometre 26 of the survey, but which is 27 kilo-

The Isthmian Canal, viewed even in its narrowest aspect, is one of the greatest engineering propositions now before the nations. Seen broadly, it is the most important pending addition to the commercial and economic equipment of the world—the largest factor soon to be added to the work of utilising, to the fullest, the earth's material resources. Its influence will be felt in every department of human activity, but foremost of all in the workshop and the factory.

metres from the Atlantic, I passed, upon another small steamer, without obstruction to the pier at Christophe Colombe; yet much of the once completed canal has been silted up and will require to be again excavated; but this is only an expense, not a difficulty, and does not require to be attended to until the more serious parts of the work are near completion.

I had always heard of the Chagres River as the imposing and irremediable difficulty which rendered this route impracticable for a canal, and I now feel much astonished that any engineer should have lent his voice to confirm such an opinion. The Chagres, even in time of flood, is a comparatively small stream; it is crossed by the railroad on a bridge 625 feet long, obstructing the channel with five heavy piers, yet this bridge has stood there about fifty years. Below the railroad there are no tributaries which increase its volume sensibly; it flows through a rather wide valley where there is plenty of room for it and for the canal. Since the resumption of work on the canal several independent channels for the discharge of this river have been provided, parts of the old bed being occupied by the canal. Of course, in its upper portion this river is a mountain torrent, and where it is on the same level as the canal it must be provided for in time of flood, so that it may not overflow into the canal. The present scheme of the Canal Company, to control both the upper and the lower reaches of the river by two dams, seems a good expedient; the upper artificial lake will afford a permanent supply of water for the higher levels of the canal and the lower lake will form an integral part of the navigable canal. It would have been quite as reasonable for opponents of the Erie Canal to have argued that the Mohawk River would render the Erie Canal impracticable as it is now to express a fear of the Chagres as an obstacle to the construction of a canal through the Isthmus.

Indeed, there is only one real difficulty, which will be to raise the necessary funds to be expended where there had been so much waste before. The Culebra cut is perhaps the greatest excavation ever un-

THE ENGINEERING MAGAZINE values the privilege of giving, at so significant a time, the carefully formed opinions of so high an authority as Mr. Paine, Past President of the American Society of Civil Engineers. The basis of his opinion is his own personal examination, just completed, of the ground and the work accomplished. The weight of his opinion needs no demonstration to an audience familiar with his long and successful direction of large engineering constructions and his intimate association with railway and steamship transportation enterprises. But with a view of putting directly before the eye the magnificent sufficiency of the Panama Canal and of the studies and preparations made for it, THE ENGINEERING MAGAZINE presents, with this issue, a large map of the line, showing to some extent the work accomplished and the minute surveys of every detail in any way affecting the undertaking.

The relations of Mr. Paine's article to previous publications in the Magazine are briefly sketched in an appendix to this paper. THE EDITORS.

dertaken—I believe it to be the biggest; but it has been attacked in the most fearless manner, and, since the resumption of work by the New Canal Company, without any cessation; several thousand men with the necessary excavators, trains, etc., have been and are at work daily upon it. It has seemed to me the most difficult problem here is to find places for depositing this mountainous mass, after it has been excavated, but I am assured there is room enough and to spare.

There are many other good problems for the exercise of engineering ability which would take too long to describe, and I do not wish to minimise the real and quite serious problems of that kind which are presented by the Isthmus; but I declare that "the Chimeras dire" which have been so much talked of, never had any existence, and upon the approach of intelligent exploration they disappeared.

The engineers of the company say that about two-fifths of the work necessary for the completion of the canal at the level adopted for the bottom of the summit level is already done. This level will be 68 feet above tide.

It has been generally known that there was an enormous preparation made for the prosecution of the work by the original Canal Company; yet I had not received even a faint impression of its extent until I came upon the ground. The Isthmus, along the line of the railroad, is covered with dwellings, sidings, contractor's plant, and materials for construction of every description. The dwellings having been built of galvanized corrugated iron have suffered little depreciation; they could house twice as many officials and workmen as are likely to be at any time employed. The scale upon which these things were done is illustrated by the fact that the old company built at Panama, upon the Ancon Mount, a beautiful group of buildings for a hospital at a cost of two millions of dollars, which is very little used, but is maintained in good order by the present Canal Company under the care of Sisters of St. Francis. The company has a branch hospital at Colon, and a sanitarium on the Island of Taboga, which is as large as a summer hotel. All these very little used, but ready. As to the plant, of dredges, barges, dump-cars, excavators, boilers, pumps, track, etc., only an inventory could give an idea; for instance, there are four hundred and twenty contractors' locomotives. All these things are on the ground, and with a little oiling and slight repairs are ready to resume work. There are machine shops fitted up completely, with foundries attached, ready to effect any required repairs, and warehouses containing all the materials necessary for making them. Doubtless many of the dredges will need extensive repairs on their hulls, but there are ship-ways and

shops expressly for their accommodation. Out of curiosity I went through twelve of the commissary's long storage buildings at Colon, in which each class of material is neatly piled, numbered, and catalogued, so as to be available upon requisition. Every conceivable material, tool, or piece of apparatus which may be needed for special work or for repairs is in the warehouses; from tacks, screws, files, up to rotary pumps of, say, 20-inches diameter of discharge; even crockery for household use and water closets.

But all these materials and apparatus on the spot, ready for business, will seem of less importance to an engineer than the perfect state of preparedness of the surveys and plans. Every site has been explored, sounded, drilled, and tested; so that the exact character of every cutting, foundation, and superstructure is shown upon elaborate drawings. Practically, there is no more surveying or studying to be done; even if a proposed structure were to be modified, the information required for the engineer's use is ready in the office. These accumulations are the result of the long delay which has occurred in the resumption of work, during which time a large force of engineers has prosecuted the study in detail of every feature of the canal. How great a saving in time and of what enormous value as a guarantee of safety these studies will be, when work is again being driven, engineers who have been hurried before will understand.

The New Canal Company appears to have felt the wisdom of Washington's injunction, "In time of peace prepare for war." The fact is, that splendid engineering talents and eminent scientific abilities have been engaged upon the problems of the Isthmus for a long time, and there can be no more doubt of the substantial sufficiency of their plans and estimates than we should have as to any minor public work which had been examined with care.

There is one more chimera deserving of special attack, and that is the idea that the Isthmus is remarkably unhealthy. The great preparations made by the old Canal Company indicate that it was expected to be so; perhaps the care taken by that company in the drainage of the sites chosen for its buildings and the concentration of the flow into the large streams, have rendered the country more wholesome; certain it is that there is no more sickness among the very considerable population now on the Isthmus than there is among any other equal number in the tropics. The railroad and canal employees now living there are perfectly free from any unusual diseases.

The railroad in operation, and so close to the canal that a siding may be connected with its banks at any desirable point, is a material

advantage in the construction of this canal; there are sidings now laid at nearly every station, for the accommodation of the canal plant, which have been disconnected from the railroad tracks, yet only require the replacing of a few rails to be ready for the delivery of supplies. I should guess that the Canal Company must have fifty miles of such tracks, with rails for as many miles more, but this is only a guess. The Canal Company maintains a telegraph line and a telephone wire across the Isthmus, with frequent stations.

I may point out that there are good harbors at each end of the Panama route which are in daily use by several lines of steamships, and also that these harbors are provided with the usual adjuncts, such as wharves, warehouses, coaling and watering facilities, and machine shops, where ordinary repairs can be made. Also that the value to commerce of any ship-canal will be about inversely as the square of its length when compared with that of another. Now, if we are really interested in having a canal between the oceans, here is one much shorter than any other possible line, already half built, if the extent of preparedness is taken into account; why not take hold and build it?

It seems to me that no engineer can cross the Isthmus without being convinced, as I am, that this is a perfectly practicable route and the most desirable one for a canal. CHARLES PAINE.

It may be taken as assured that a very few years will see the completion of a canal across the American Isthmus—the open- of a gateway through the one remaining barrier in the great direct sea-road around the world. To quote Prof. Haupt*: "Probably at no place on the globe would the economy of distance be so great as here, and certainly nowhere else has so assiduous search been made for a passage between the two oceans. * * * The question may well be asked: Why then has it not been completed long ere this?

"The answer must be found in the history of all great undertakings. First, it required some centuries of exploration to find the proper route; second, when discovered, the problem seemed to be beyond the mechanical and financial resources of the times; third, as it was expanded, and adapted to the increasing demands of commerce, additional obstacles and difficulties were presented, of a complicated nature, but having little to do with the physics of the problem."

The situation in this case was indeed complicated by the fact that the first serious effort—an effort which, in the light of the most

* National Influence and the Isthmian Canal. Lewis M. Haupt. THE ENGINEERING MAGAZINE, July, 1898.

searching study, has proved to be admirably conceived so far as the physics of the problem are concerned, ended in financial disaster.

"The new company was definitely formed on October 2, 1894. * * * In 1895, the company employed 3,000 men, and 370,000 cubic metres of material were removed; in 1896, the figures rose to 4,000 men and 700,000 cubic metres; and, in 1897, to 3,600 men and 960,000 cubic metres. Thus the terms upon which the concession was originally granted have been complied with, and work of substantial and permanent value has been carried out.

"In the discharge of this duty they obtained the best engineering advice available, and formed a competent engineering staff. In addition to this, acting under special legislative enactment, they summoned to their aid a number of outside engineering experts,—French, German, Russian, American, and English; all of the men holding or having held, responsible positions, impartial in judgment. and possessed of such experience as to render each man specially fitted to advise on the proposed design and method of construction. In this way the *Comité Technique* was formed.

"Under the direction of the *Comité Technique* the whole of the route of the canal and of its collateral works was accurately surveyed and contoured; borings were made, trial pits sunk, streams large and small, (including the wayward Chagres) gauged, meteorological observations made and recorded, and generally a mass of facts accumulated through which the *Comité* was enabled to agree upon a project for the completion of the Panama canal, with which the new company is prepared to face, to invite, the criticism of the world."*

Such is, in brief, the earlier story of the Panama canal, which Mr. Paine brings down to the very beginning of 1900 in his summary of the conditions as he has just seen them. But meantime another complication of the question has been introduced by the rival attitude assumed by the advocates of the Nicaragua route. However urgent the need of a deep waterway across the Isthmus, the attempted simultaneous construction of two would seem a deplorable waste and probably a fatal disaster to the "least fit," or even to both, of the enterprises. More, it would be a crime against the economy of effort which is the guiding principle of the age. The time is ripe for "the selection of the best possible route and the best possible proposal."

This Magazine has endeavored faithfully to further this purpose by summarising the claims of both routes, and more especially the evidence by which they are supported.

* The American Isthmus and the Interoceanic Canal. W. Henry Hunter. THE ENGINEERING MAGAZINE, February, 1899.

And at the very outset, a marked difference is to be noted. The history of Panama, with all its faulty past, is the history of actual work accomplished. The construction is approximately one-half finished. The Atlantic channel, 24 kilometres long, and the Pacific channel, nearly 13 kilometres long, have been excavated to full width and need only dredging to restore the full depth. The heaviest work on the great cut is done. The terminal harbors are open to commerce.

But the record of Nicaragua is little more than a record of "concessions." "Since 1893 the financial situation has, in the words of the present president of the Construction Company, 'been bad.' It has been difficult to obtain money, and but little work has been executed. Prior to that date, a length of one thousand feet of pier-work had been constructed at Greytown, a channel had been dredged on the foreshore, and some three-quarters of a mile of the canal had been formed by dredging in the low, swampy ground. A single line of railway had also been formed across the lagoon, from Greytown to the site of the first lock, the length of the line being about eleven and one-half miles. These works, with the addition of certain telegraph lines, represent the sum total of the efforts which have been made to construct a waterway on the Nicaragua line." *

Backwardness of construction might be considered unimportant, if there were strong evidence of the possibility and advantages of the route. But it is with regret that we have repeatedly been forced to deplore the scarcity and unsatisfactory nature of the information concerning the Nicaragua project. "The facts, indeed, are so curiously inaccessible that it is hardly possible to obtain them except in the report prepared by the board of engineers appointed, pursuant to a provision in the act of Congress approved March 2, 1895, for the purpose of ascertaining the feasibility, permanence, and cost of construction and completion of the Nicaragua canal by the route contemplated. * * * It is in the highest degree unfortunate that the edition of the report was so inexplicably limited that hardly a copy can by any means be procured by a private citizen." †

The meagreness of the facts can best be expressed in the words of the board, whose ability and disinterestedness cannot be impugned. The observations of the Nicaragua survey, with respect to rainfall, are "scattering and unsatisfactory"; "the company has omitted attention to the matter and made no careful gaugings at any point"; "the most

* A Review of the Nicaragua Canal Scheme. W. Henry Hunter. THE ENGINEERING MAGAZINE, March, 1899.

† The Absence of Facts about the Nicaragua Canal. Charles B. Going. THE ENGINEERING MAGAZINE, June, 1896.

serious problems affecting the design and construction of a canal system at the present time are those involved in the heavy rainfall and consequent discharge from the lake and streams," yet "on these points the existing data are seriously defective both in respect of number and continuity"; an important dam is planned near Lock No. 3, but "no borings have been taken at this site and it is not known whether a suitable foundation for a concrete dam can be found"; "the canal company has no detailed plans of the locks and other structures for which its estimates are made, and the board has had to prepare preliminary drawings for the lock estimates." Along the great central-divide cut, 3.15 miles long and 324 feet deep, "new borings * * * are indispensable"; for the east divide cut "the data at hand are so scanty and defective that no satisfactory treatment of the subject is possible." "There are no drawings nor plans for" the guard gates at the San Francisco basins (the series of sixty-seven embankments which are conceded to be the weakest feature of the route) nor is it "clear for what amount of drainage, or for what area, these weirs are intended to provide, as the streams in question have not been gauged in flood nor their watersheds measured." "The company"s surveys are mainly devoted to topography, and did not include the collection of hydraulic data." "It appears that the company has made no surveys or examinations of the sixty-nine miles of river between Ochoa and the lake, with the exception of a partial survey by compass which is laid aside as valueless." "The profile furnished by the company is little more than guesswork."

In the time which has elapsed since the Ludlow board made its examination, however, it is to be assumed that the studies have proceeded and that full data have been obtained. The matter, so far as the important factor of the action of the United States is concerned, will doubtless depend wholly upon the report of the eminent commission now examining the question. Every facility will of course be afforded them for the study of both projects. Their conclusion can be awaited with patience and confidence. C. B. G.

The Isthmian Canal, in its most interesting general, political, and economic relations, as well as its engineering aspects, has been treated previously in the following articles published in THE ENGINEERING MAGAZINE:

America's Interest in the Nicaragua Canal. Warner Miller. March, 1893.
The Absence of Facts about the Nicaragua Canal. Charles B. Going. June, 1896.
National Influence and the Isthmian Canal. Lewis M. Haupt. July, 1898.
The Nicaragua Canal in Its Commercial and Military Aspects. Joseph Nimmo, Jr. Aug., 1898.
Equipment, Management and Economic Influence of the Ship Canal. W. Henry Hunter. Dec., 1898, & Jan., 1899
The American Isthmus and the Interoceanic Canal. W. Henry Hunter. Feb., 1899.
A Review of the Nicaragua Canal Scheme. W. Henry Hunter. Mar., 1899.

ACTUAL EXPERIENCE WITH THE PREMIUM PLAN.

By H. M. Norris.

IN the preceding issue of this Magazine I gave an account of the effort to introduce one of the most modern wage-systems into a shop which, in situation, general character of output, and personnel of its working force might be considered fairly typical of American mechanical establishments.* The importance which the experience might have as an individual case is greatly enlarged by the late developments when the matter came before the International Association of Machinists, for their action defines the gradually crystallizing mind of American union labor. Many writers in this Magazine have based their belief on the triumphant future of the American machine trades upon the American workman's freedom from the industrial heresies and the thralldom to the union which in Europe so strongly oppose the movement toward economy of production. To all who are interested in the adjustment of the problem, this "leading case" is offered for study—I hope for profit—in finding a solution.

My former paper told of the painstaking study of the introduction of the system into the shops, the apparent initial success, the rapid change to dissatisfaction and friction, the seeming covert efforts of some of the men to defeat the plan, and the sudden and serious strain brought on when one of the flagrant offenders was dropped. No strike occurred, though the men's demand for the re-employment of the offender was refused; but an absurd solution was found in not insisting that the men should accept the extra wages earned by them under the premium plan, and freely offered by the company. The plan was, to this extent, withdrawn, and a final earnest effort to induce the men to accept it on trial for a year was suspended pending a promised consideration of the whole matter of the premium system by the convention of the International Association of Machinists, which was then near at hand. Mr. McConnell, the grand master of the association, promised to refer the general question and my particular proposi-

* The works of The Bickford Drill & Tool Co., of which Mr. Norris is engineer and works manager.

This review began in THE ENGINEERING MAGAZINE for January, 1900. Preceding papers of closely related interest are:

Methods of Remunerating Labor. P. J. Darlington. June, 1899.

Systems for the Remuneration of Labor. P. J. Darlington. Sept., 1899.

tions to the convention in his biennial report, and there the matter rested at the stage described in my former article.

Three weeks after the opening of the convention I wrote again to Mr. O'Connell, saying that it had been reported that the premium plan had been strongly denounced, and asking for an early submission of the promised report. The reply stated that the report of the proceedings would very soon be ready for distribution, and was accompanied by a copy of the grand master's biennial report. My acknowledgment of this letter read as follows:

"Dear Sir: I have your valued favor of the 24th, together with copy of report of the grand master machinist, for both of which I beg to thank you.

"I have not yet had an opportunity of examining the latter in detail, having read only that portion which relates to piece work, but it does not seem to contain the information I am seeking, namely, the decision of the Association in regard to the use of the premium plan. Possibly the proceedings contain this knowledge, but in case they do not, will you be kind enough to advise me by letter, in order that I may know what to expect from our men in case we should think best to ask them to agree to give the system a year's trial."

To this letter I received no answer, but in course of time came a copy of the proceedings, from which I make the following extracts, quoting first from the grand master's report:

"One of the most important matters to be considered by the delegates of this convention is the question of piece work, and other plans of paying for work performed by machinists.

"There is no denying the fact that piece work and the premium plans are constantly growing in our trade. Although we have succeeded in many instances in preventing the introduction of piece work, yet the volume of the same is increasing. It is useless for us to any longer hide our heads under a bushel, refusing to squarely face the matter. There is no one who believes more firmly than I do that piece work is detrimental to our trade; it not only works injury to the tradesman, but results disastrously to the employer. We might as well follow the example of that famous bird, the ostrich, that buries its head in the sand, believing that if it cannot see, it cannot be seen, as to continue our present method of fighting piece work.

"First, because we allow our members in some shops to work under the system; although the same firm may own the shop across the street, our members cannot accept the system there under our constitution. When we go to employers with this state of affairs existing, we are placed in a most ridiculous position.

"During the past two years we have spent more money and devoted more time of the officers to the question of piece work than to any other portion of our trade. In many instances our efforts failed. As a result, many lodges were lost to the association. I call your attention to the conditions prevailing on the Chicago, Burlington and Quincy Railroad, where we lost

four lodges because of the introduction of piece work. We did all in our power to assist our lodges located on the road to resist the introduction of piece work, but there being a number of our members who were desirous of accepting the plan, made it impossible for us to do anything. In fact, letters were received at headquarters from our lodges on the system, insisting that the grand lodge keep its hands off the affair.

"Lodges have been lost in other sections of the country, not because the grand lodge made no effort to prevent the introduction of the system, but in many instances because, when the grand lodge tried to prevent it, those who were desirous of accepting piece work succeeded in disrupting our lodges.

"A new plan is now being tried in some localities which in the main does away with the old practice of piece work and introduces what is known as the premium plan of paying for work performed. This guarantees to the men that they will receive their regular wages whether the same is made by them or not.

"Mr. F. A. Halsey, associate editor of the *American Machinist,* in the March 9th issue of that paper, gives a plan which is being rapidly taken up by the manufacturers. The Bickford Drill & Tool Company, of Cincinnati, too, made an effort to introduce the system. But members would not accept it. I was called to that city and had an interview with Mr. H. M. Norris, the superintendent of the company. I explained to him that nothing could be done in this matter until after our convention, but if he would agree to let the question stand as it was for the present I would submit his plan to the convention for consideration. This he agreed to. I herewith attach his proposition:"

Mr. O'Connell gives my proposition * in full, after which he says:

"The delegates to this convention will fully appreciate that some definite action must be taken as our position in the future regarding the introduction of piece work and premium plans. In my opinion it would be wisest policy for us to face the inevitable, select the best system, then control it. I am satisfied if this is done we can rapidly unionize a large number of manufactories which we are now constantly fighting."

During the afternoon session of the fifth day of the convention the chairman stated that the grand master machinist had requested the committee on law to present a plan for piece work. Their deliberations resulted as follows:

"Recognizing the great inroads that the premium plans and the two or more machine systems are working into the machine shop of the present day, we believe it is essentially necessary that legislation of a definite nature should be enacted whereby the International Association of Machinists can successfully manage and control them. We realize that to further combat the system of premium plans will be suicidal on our part when we consider the fact of the many members of our organization being engaged in them at the present time.

*See THE ENGINEERING MAGAZINE, January, 1900, pp. 583-584. The eight sections of Mr. Norris' proposition are embodied in the report of the committee on law, page 692, this issue.

"Your committee on law realize that this is a knotty problem to solve in presenting a plan whereby we can successfully deal with this question on the start. We do believe, however, that the plan herewith submitted will, in a measure, serve as a guide wherever the system is in operation, or may be introduced in the future. We might also add that practical experience is the greatest teacher in all things, and during the next two years we will get the benefit of it, at which time will be better able to amend or improve the plan herewith submitted.

"Members of the International Association of Machinists can accept premium work under the following conditions.

"1st. That each employee shall be guaranteed his regular day's-work wages.

"2nd. That the time limits shall never be lower than the average time made with the same tools under the day's-work plan.

"3rd. That no one shall be discharged because of failure to reduce his time below the limits.

"4th. That in addition to his regular wages each employee shall be paid one-half of his regular hourly rate, for each and every hour he may reduce his time below the prescribed limits.

"5th. That the limit, once fixed, shall not be lowered except through the introduction of new methods of doing the work.

"6th. That all the premiums shall be paid within two weeks of completion of the work upon which they were earned.

"7th. That at the end of one year's time the plan will be withdrawn from all those not wishing to continue working under it.

"8th. That if withdrawn the employee shall not be required to work at the same rate without an equivalent in wages.*

"9th. Any member of the I. A. of M. working at the premium work system shall not be permitted to earn more than 10 per cent. in excess of the average wage paid in that locality. Shop committee shall ascertain each pay day the amount earned by each member under the premium work system. All over 10 per cent. he may earn shall be forfeited to the lodge of which he is a member, and report same to the financial secretary of the lodge.

"10th. No member of the I. A. of M. shall be permitted to run two or more machines except where an agreement has been entered into with organization and the firm. Such agreement shall only apply to special machines and shall require all machinists to be members of the I. A. of M."

During the discussion which followed the reading of this report, one of the members remarked that no union man could entertain the idea of piece work or of running two machines. Another said: "Piece work has come to stay. We must either abolish it or control it. The only way to abolish it is by the coöperative commonwealth, but we are not ready for that yet. In a shop in New York the men work piece work or premium plan, and all they receive above $18 per week is devoted to a defense fund. The last clause of the plan, as submitted

* Conditions 1-8 are identical with the proposals framed by Mr. Norris for the introduction of the premium plan into the Bickford shops.

by the committee, provides for an agreement on the part of the organization and the firm. We can get agreements with nine-tenths of the firms in this country, and I move that we adopt last clause of committee's amendment and insert 'or accept piece work' after 'two or more machines.'"

The remarks of some of the speakers were indicative of the general temper. One said that "in his section they had tried to introduce piece work. Man after man had quit work because of it. Now they had got it where the master mechanic said: 'we are going to give up piece work; it is causing us too much trouble.'" Another "thought it was a hard nut to crack, but the piece work could be abolished. They had done it in one shop. When the manager was first approached about it he only laughed, but they had dinged at him and donged at him, until he had abolished it." Still another told how "they had driven out piece work by a man taking four weeks to do a job which he could have done in two." To the argument that "the plan submitted by the committee gives a year in which to try the agreement, at the end of that time it could be withdrawn," an opponent responded that "if we contracted a disease for a year, we could not then get rid of it. It was so with piece work; if we worked it for a year, we could not then drop it. He had come to the convention pledged to vote against it." The next speaker said "piece work was here and bound to stay, so let us settle the question to-day, or two years hence we would not have ten delegates to the convention."

The grand master's report on piece work was then read, after which Mr. O'Connell addressed the convention, saying that "after great study he felt that it was his duty to bring this matter up, as the manufacturers of the country are making strenuous efforts to introduce the piece-work system. He then explained the difference between the piece-work system and what is known as the premium plan. He reported several interviews with firms, and advised the convention to adopt some law that would allow the officers of the I. A. of M. to cope with this evil. Said he hoped some means would be devised to regulate this system, as we had lost nearly all our lodges on the C., B. & Q. from it."

It was then moved and carried "that a committee of five be appointed to draft a plan to govern this system." This committee reported as follows:

> "Your committee beg leave to report that, after due deliberation, we have become convinced that, under the present conditions existing in some parts of our country, we are forced to provide some legislation that will compromise, in a manner, between those who ask for protection where piece

work exists, and those who appeal to us for a law which will prevent its introduction; and we further realized the fruitless attempt to drive the monster from among us, at the Kansas City convention, when Section 3, Article XXII., in our convention became a law, and which from its date has been a dead letter. We therefore annul Section 3, Article XXII., by striking all out and substituting the following:

"That our judicial officers be given discretionary power to treat with employers where piece work now exists with I. A. of M. members, and to make agreements as prescribed by the premium system, and thereby control and eventually abolish piece work in any form."

The remarks of individual speakers again furnish an index to the attitude of organized American labor to the newer wage systems: "There is no provision in this report to prevent a man from doing piece work. No fine is placed on him. If you want to stamp it out, make it cost a man so much that he will not want to do it." * * * "The plan submitted will control it as much as it ever has been controlled. This prevents piece work from spreading where it does not exist. The way to put that law into operation is to give the executive officers power to make contracts where piece work now exists." * * * "It gives the executive officers a chance to prevent piece work from going any further. It cannot come into places where it has been stamped out." * * * "Put it in the hands of the executive officers to accept where it cannot be helped, and stamp it out where possible." * * * "The premium plan is just as bad as piecework. In my city the premium plan was introduced in a shop. The men earned $16, $18 and $24 a week. They did not know where to stop. The company had to cut them down. I do not wish to see the premium plan endorsed one iota." * * * "We do not want piece work in any form, but we must provide for it where it exists. It was not right to have a law that was violated, as the past law has been. To substitute the premium plan where piece work now exists was a compromise between those who did want piece work and those who did not." * * * "We are not in a condition to-day to antagonize the shops that are already working piece work." * * * "I work in a piecework shop. The men agree among themselves how much they will earn; but I am opposed to the plan in principle."

On call of the question, the report of the committee was adopted.

It is to be regretted that Mr. O'Connell's explanation of the difference between the piece work and premium systems is not recorded on the proceedings, since we have no other means of judging the comprehensiveness with which it was made. Biassed himself, according to his own declaration, it is safe to assume he said little to influence a

biassed audience. It is encouraging to note, however, that there are in the union at least a few men who realize the fruitlessness of combating the inevitable. Piece work in one form or another is here to stay. It can never be driven out. The union can forbid its members working for less than a stipulated amount per day; it can say that their earnings shall not exceed a certain figure per week; it can even insist that they all work at exactly the same rate per hour, but piece work will continue forever, the term meaning certain pay for certain out-put; and if manufacturers are prevented from grading its employees according to their individual merit, it means simply that all workmen will be obliged to maintain a certain out-put in order to hold their jobs at all, the rate of pay and amount of out-put still continuing hand in hand.

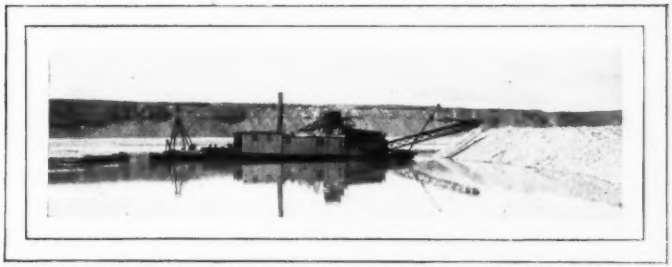
In the words of the memorable Lincoln: "You can fool some of the people all the time, and all of the people some of the time, but you cannot fool all the people all the time." The American workman is no dummy. He will not long be deceived by the *ignis fatuus* of the union. There is sure to come an awakening sooner or later, and when he realizes that the organization to which he was led to look for a betterment of his condition is passing resolutions forbidding him "to earn more than 10 per cent. in excess of the average wages paid in that locality," it is little wonder that there should be disruptions in the ranks, and many losses of lodges to the union. Can one imagine a more inane proposition than that contained in the 9th paragraph of the law committee's report, which, if the average rate of wages is 22 cents per hour, prohibits a 26-cents-per-hour man from earning more than $16.92 per week, an increase of but .022 cent per hour? This, it will be seen, offers a greater incentive to the poor workman than to the good. If average wages are 25 cents per hour, the 20-cent man is permitted to earn an increase of 12½ per cent. of his wages, while the 30-cent man is restricted to an increase of but 8 1/3 per cent. of his wages. Affairs have indeed reached a lamentable state when the workman himself puts forth the obstacle to a betterment of his condition, and sets at naught all efforts in his behalf.

The situation becomes more critical every day. Intelligence from New York City announces the federation of 500,000 workmen, begun at this writing, hoping thereby to end the career of strikes, in supplanting present methods by arbitration. The purpose is a good one, and deserves our enconiums, could we credit it. We are, however, led to ask, can this promise carry much weight in view of the fact that labor organizations recognize and favor such deceptions as are prac-

ticed by some of their members and reported in open convention without a dissenting voice? Take, for example, the statement of the speaker who acknowledges driving out piece work by taking four weeks to do a job which he could have done in two.

It is asserted that the spirit of labor organizations is the eternal brotherhood of man; that this is the corner stone upon which it so successfully builds; that in this sentiment lies the strength and hereupon rests the glory of the institution; all of which is beautiful and would redound to the credit of labor were it true. Is it not true instead that organized labor is assuming the bigoted position of the churches of old, claiming that no good exists outside of its fold, salvation being possible only in its ranks? Is it the spirit of eternal brotherhood that demands the discharge of a co-laborer, an excellent workman, a man of sturdy habits, admirable probity, born to earn his livelihood like his organized brother, by the sweat of his brow, for no other reason than that, to his understanding, membership in a union could add nothing to his force as a workman, since it desires not selected labor, but any labor? Is this the spirit of eternal brotherhood or is it the spirit of intolerant bigotry? Is it not relentless fanaticism as well as arrant knavery which admits, as was admitted in recent convention, that the men employed in a piece-work shop agreed among themselves how much they would earn, thereby frustrating the plans of the employer? What an astonishing distinction is made as to who gores the ox, for should the employer have limited the wage earning capacity of these same men it would doubtless have resulted in a strike. Again, is it brotherly love, or is it the very essence of sublime selfishness which dictates that the earnings of a capable man, of excellent character and steady habits, on whom a large family may depend for support, shall be no greater than that of a man perhaps having no one dependent on him and whose work and habits may be far from exemplary?

In view of all the anarchy practiced, the demands made, the want of recognition of humane methods employed, there may be forced into the ring a new factor, namely: an organization of employers, a union founded for the purpose of self-protection, demanding, only, what is right and fair. Should the number of segregated, isolated, employers in sympathy with each other ever become a concentrated, vigorous, organized force, labor would be confronted by a panoplied wall that all its combined efforts would find it futile to attempt to overthrow.



The Gold Dredge Chicago. Esquilant, Photo., Dunedin.

THE ORIGIN AND PROGRESS OF GOLD DREDGING IN NEW ZEALAND.

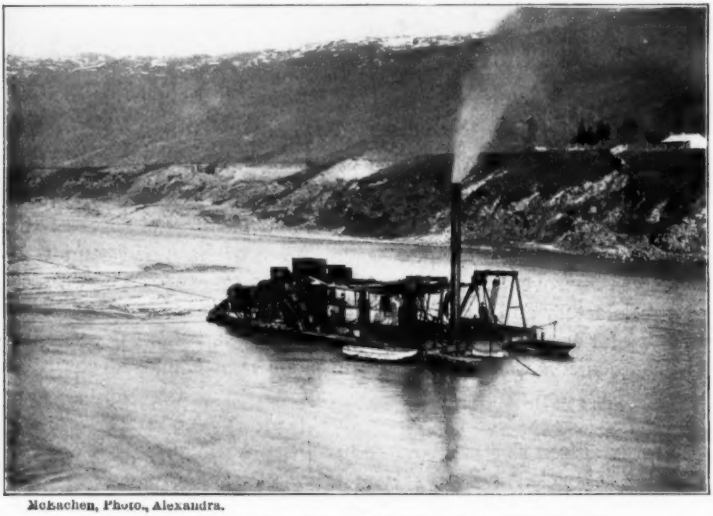
By W. H. Cutten.

THE success of dredging as a branch of the gold-mining industry in New Zealand is now so firmly established and so widely recognised as to call for little comment. In the space of the last thirty years, gold dredging has advanced by leaps and bounds, as each fresh improvement upon the early crude attempts has been added with satisfactory and stimulating results. It is now about thirty-four years, as far as can be ascertained, since the first attempt to dredge the River Molyneux was made. The machine then employed consisted merely of a strong iron ring, technically known as a spoon, to which was secured an ox-hide bag and a long pole. A rope was fastened to the aforesaid iron ring and secured to a hand winch on the bank of the river. The bucket and pole were taken out and dropped into the stream by means of a boat, the bucket being pressed by the pole as deep as possible into the wash in the bed of the river. All that remained to be done was to haul the bucket ashore with the help of the winch, the contents being then cradled in an ordinary miner's cradle.

The next step in advance was the use of a wooden pontoon, moored out in the river, upon which a hand winch was fixed at one end to work the spoon. The spoon was dropped into the river at one end of the pontoon and dragged to the other end by means of a rope attached to the winch, while one man kept the spoon pressed down into the wash; a greater quantity of wash was thus secured with less waste of time. These little spoon dredges answered very well and obtained good returns, in some instances as much as 70 to 80 ozs. of gold per

week, until sluicing operations, starting along the banks, made it impossible for the small craft to cope with the amount of drift being sluiced into the river, and one by one they were laid aside as useless.

After a brief interval, a steam spoon dredge was designed with which to overcome the drift difficulty. This was about the year 1870, and affords the earliest record we have of a steam dredge on a New Zealand river. The dredge roughly resembled the present style of machine, being formed of two pontoons held apart by beams bolted to the decks, thus leaving a well some 3 feet wide between; through this a spoon, larger than any hitherto used, was worked by means of a steam winch. For about two years this dredge apparently paid well,



McEachen, Photo., Alexandra.

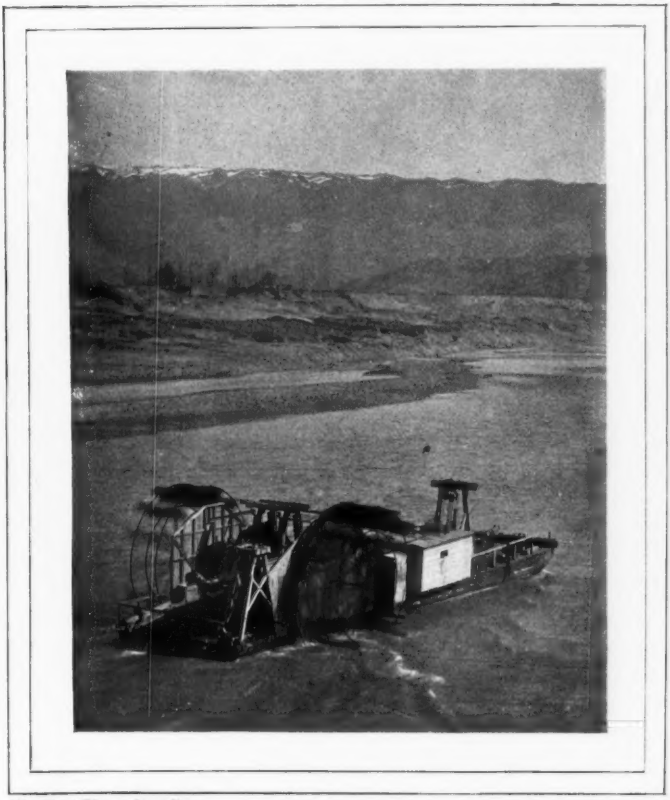
DUNEDIN DREDGE. THE PIONEER OF THE STEAM BUCKET TYPE.

but eventually she also proved useless on account of the continued increase of drift, and so had to be laid up.

The spoon dredge was superseded by the bucket-and-ladder dredge, which was first driven by the current of the river, acting on a large pair of side wheels with floats resembling the paddle wheels of a steamer. These dredges worked well so long as the gold was confined to the river beds, but were quite unable to follow the leads of gold which were found to run into the banks. Some of them have since been fitted with steam power, and have paid remarkably well.

Up to 1894, dredging operations were confined almost entirely to

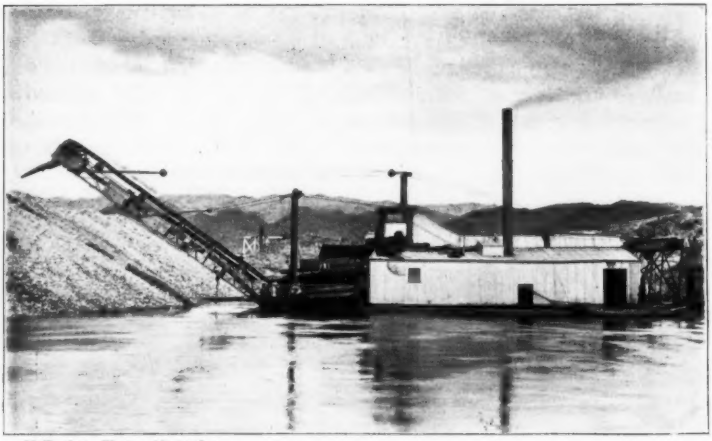
working the beds and low beaches of the rivers or flats. The high banks were unworkable on account of inability to stack tailings clear of the stern of the dredge. This difficulty for a time threatened seriously to cripple and to limit dredging operations, and it seemed as though much valuable ground would have to remain untouched. However, while working the Enterprise dredge in 1894 the author was



Esquilant, Photo., Dunedin.

THE PERSEVERANCE. A CURRENT-WHEEL DREDGE.

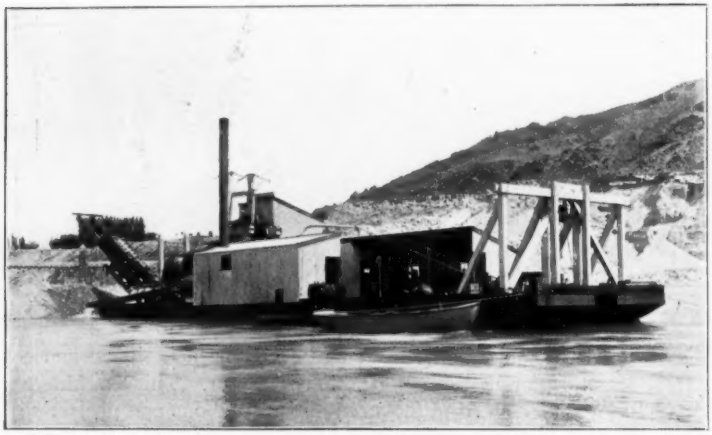
confronted with this difficulty, and to overcome it designed and constructed what is now termed a tailings elevator. This machine consisted of a ladder, fixed to the stern of the pontoons and projecting at an angle of about 35 degrees to water level. A continuous chain of flat iron trays encircled the ladder and ran over two iron tumblers, one



McEachen, Photo., Alexandra.

THE EUREKA NO. 2.

at the top and the other at the bottom of the ladder. By this means the rough portion of the wash dirt, after passing through a revolving screen and being sluiced in transit, was delivered over the elevator and dropped at some distance from the stern. In consequence of this invention high-bank claims became workable and several dredges are today eating their way into faces fully 40 feet above the water.



McEachen, Photo, Alexandra.

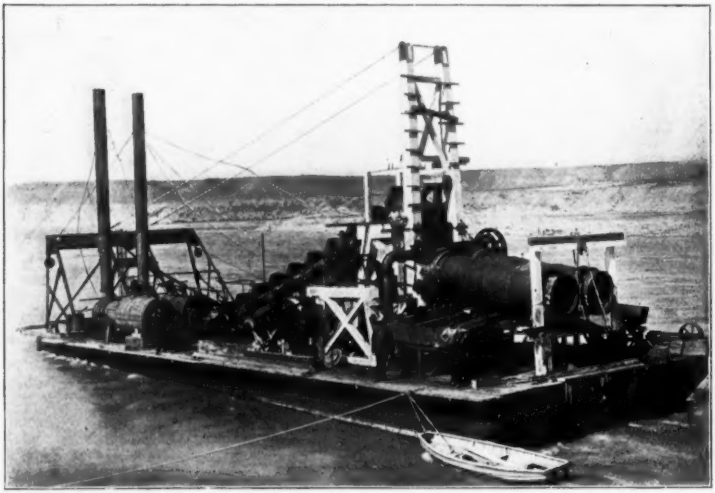
A LARGE MODERN DREDGE—THE VINCENT.

Earnscleugh, No. 1 & No. 2. Ngapara. Chicago. Enterprise. Perseverance (steam). Perseverance (current wheel).

McEachen, Photo., Alexandra. Eureka. Molyneux (hydraulic). Golden Beach.

VIEW OF EARNSCLEUGH FLAT AND MOLYNEUX RIVER, SHOWING TEN DREDGES AT WORK IN THE RIVER AND ON THE HIGH BANKS.

Having briefly outlined its early history, we will turn to the up-to-date aspect of the dredging industry and give a short description of the gold-dredging machine of 1899, selecting for the purpose of example the Earnscleugh No. 2. This is the largest gold dredge yet constructed in New Zealand. She was designed for a private company consisting of five men. The pontoons of this dredge are of New Zealand kauri, with framing of Tasmanian hard-wood, the length being 98 ft. and breadth 30 ft.; they are 7 ft. 6 in. deep aft, tapering to 6 ft. 6 in. forward. The ladder well is 5 ft. in width. There is also a short well aft, 5 ft. 6 in. wide, to accommodate the tailings elevator. The



McEachen, Photo., Alexandra.

THE EARNSCLEUGH NO. 2, THE LARGEST GOLD DREDGE IN NEW ZEALAND, IN COURSE OF CONSTRUCTION.

bucket ladder is of steel, 70 ft. long, and is capable of dredging to a depth of 38 ft. below water level. The gearing is of cast iron, heavily made and shrouded, and turned to the pitch line of the teeth.

On the gearing between the engines and the buckets is a neatly arranged friction clutch, which allows the buckets to stop when they come in contact with anything too hard or too heavy to lift, and to start again when the pressure is removed. By merely moving a lever the winch-man can at any time start or stop the buckets, without in any way interfering with the running of the engine and other machinery. The winch, which is driven by a separate engine, is fitted with seven barrels or drums, any one of which can be worked independ-

McEachen, Photo. Alexandra.

THE EARNSCLEUGH NO. 2, COMPLETED AND HOUSED IN.

ently, or the whole seven in unison, by the moving of levers. Four of the barrels are connected with the quarter lines which move the dredge from side to side in working a cut. The fifth barrel is used for raising and lowering the ladder, while the sixth is for the head line which holds the dredge up to its work. The remaining barrel is a spare one and is used occasionally for lifting heavy weights, or for a second head line in case of floods. These lines are flexible steel wires. The winches occupy a space 18 ft. by 6 ft., and the man in charge does not require to move more than 15 ft. to work the whole seven barrels.

There is a continuous chain of thirty-six steel buckets which work

McEachen, Photo., Alexandra.

MATAU DREDGE, ALEXANDRA. A TYPICAL MODERN DREDGE.

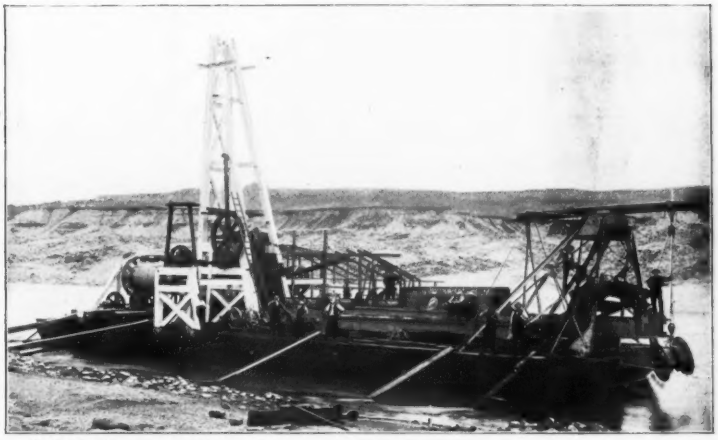
Esquilant, Photo., Dunedin.

ENTERPRISE DREDGE. THE FIRST IN NEW ZEALAND TO BE FITTED WITH A TAILINGS ELEVATOR.

The dredge is working into a low bank on the Clutha river.

over top and bottom tumblers of cast steel and are carried up the ladder on rollers 18 in. in diameter. Each bucket has a capacity of 6½ cu. ft. This dredge is capable of lifting and treating 19,800 cu. yds. of gravel per week. Her engines are surface condensing of 20 h. p. nominal. They are connected with the machinery by a 15-in. belt which absorbs all shocks occasioned by dredging rough and rocky ground. Another belt from the fly-wheel transmits power to a 12-in. centrifugal pump, which supplies water for washing the dirt. This pump answers a double purpose, as it draws the water through the condenser of the engine and assists in keeping it at a normal temperature, and prevents the tables from freezing in cold weather. There are two boilers, each of 16 h. p. nominal, carrying 140 lbs. pressure. These were specially designed for the use of dirty water and are what may be called loco-tubular with circular furnaces. The furnace end is larger in diameter than the other, in order to reduce weight of boiler and contained water, and to allow for the unequal expansion which is experienced in boilers of the Cornish type when fired straight through without returning the flue on the bottom. Both engines and boilers were imported from England. The elevator consists of a ladder, in the form of a box open at the top and latticed at the sides to form a girder. It is fixed to the stern of the dredge by a pivoting shaft, and is supported by four steel-wire ropes leading to masts 40 ft. high set in

the center of the dredge. It is stayed at the sides by two steel pipes about 9 in. in diameter, and by two steel-wire ropes. At each end of the elevator there is a pair of light seven-sided tumblers over which the buckets revolve, and inside the upper portion of the ladder are fixed six pairs of rollers on which the buckets travel; there are a corresponding number of rollers on the lower part to support the returning empty buckets. The elevator is driven from the lower tumbler by means of a gearing connected with the main gearing by a belt. All the machinery, excepting the centrifugal pump, air pump, and condenser, is above deck and easily accessible for repairs. After the dirt has been lifted by the buckets, it is discharged into a double shoot made of steel, and thence it falls into two revolving steel cylinders or screens, each 16 ft. 6 in. long, 4 ft. in diameter, and perforated for 12 ft. of their length with holes ranging from 5-16 in. at the upper end to 1-2 in. at the lower. These screens have a fall towards the stern of the dredge, and each contains a perforated water pipe. As the dirt passes slowly through the screens it is subjected to a continuous shower of water from these pipes, and the smaller portion of the dirt, with the gold, is thus washed through the screen holes onto the tables below, while the rough wash and stones pass out into the elevator buckets. The tables for saving the gold are covered with lengths of cocoanut matting, and under these calico is laid to save any fine gold which might otherwise escape through the matting. The matting is kept in its place



McEachen, Photo., Alexandra.

THE NEW ALEXANDRA DREDGE.

by wooden battens wedged to the side divisions of the boxes. Wire netting is largely used on dredges to cover the mats, as it forms ripples which aid in saving the gold, and protects the mats from wear.

The working expenses of the Earnscleugh No. 2 can be set down at about £60 a week. This includes wages, fuel, wear-and-tear, oil, waste, etc., thus making the cost of lifting and treating a cubic yard of gravel a little less than one penny. This is allowing for 25 per cent. of loss for buckets coming up only partially full. The capital cost of the Earnscleugh No. 2, in working order upon its claim, was £9,500.

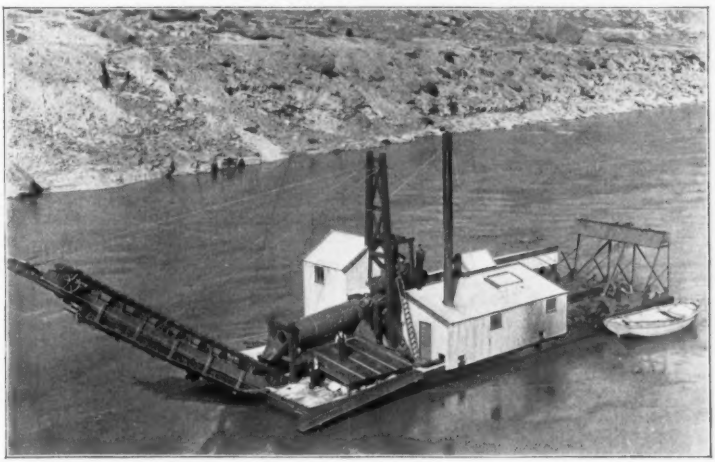
The process of "washing up" and "streaming down"—or, in other words, the releasing of the gold from the mats, requires a few words of explanation. The mats, both calico and cocoanut fibre, when lifted are carefully washed in a large wooden box or trough about 2½ ft. in depth by 4 ft. long and 3 ft. wide. A miniature tail race, consisting of an inclined flat wooden tray about 12 ft. long, is then erected. At the upper end is placed a box some 20 in. square, fitted with a perforated iron tray and having the bottom open; both box and tail race are covered with small mats of green baize or plush to catch the gold. The dirt is then scooped with a long-handled shovel from the large trough, and is placed upon the perforated top of the box, and washed by means of a hose. After all the wash dirt has been passed through the streaming-down box, the plush or baize mats are lifted and washed in an iron bath; the coarser gold is then separated from the finer by means of wide gauze sieves, and the return is then dried, cleaned, and finally weighed and sealed up. The whole operation takes four or five hours to complete, according to the quantity of gold.

At the present time the dredge which heads the list in the way of good returns is the famous Hartley & Riley. She was built by a firm of Dunedin engineers at a cost of about £5,800, from designs by the author's firm. Although not very successful at the start, it was not long before she got onto extremely rich ground, and from thenceforth her returns have been phenomenal. For the last fifteen weeks she has won from the river 7,950 ozs. of gold, giving an average of 530 ozs. a week. The Hartley & Riley holds the record return for any gold dredge working in New Zealand, viz., 786 ozs. of gold for six days' work, the previous record being that of the Electric Company's dredge —658 ozs. Of course, the Hartley & Riley is an exceptionally rich claim, and though, no doubt, many of the machines now in course of construction, and some of those already at work, may give very good accounts of themselves in the future, it is hardly probable that we shall hear of many larger returns than those above quoted. This, however,

is a matter of conjecture. Improvements may possibly be made upon the present method of lifting and saving gold from rough and rocky claims. But as a matter of fact, in spite of various attempted improvements, there have been no appreciable alterations during the last nine years in the process of treating and saving the gold won by dredges.

An ordinary sized machine costing, say, £3,000 to £4,000, if it can be relied upon to secure even 20 ozs. a week, gives very good returns.

There are about one hundred dredges working in New Zealand, 90 per cent. of which are in Otago and the balance on the West Coast. Seventy-six of the total are owned by public companies and the remainder are the property of private syndicates and individuals. To



McEachen, Photo., Alexandra.

THE HARTLEY AND RILEY DREDGE—THE "KING OF GOLD DREDGERS."

The returns from this dredge averaged 530 ozs. of gold per week for fifteen consecutive weeks, the record week being 786 ozs. It repaid its entire capital cost out of less than three consecutive weeks' returns.

show the faith evinced by New Zealanders in the future of the industry it may be mentioned that, since the beginning of this year, considerably more than one hundred companies have been floated with an aggregate capital of £1,250,000.

Up to the present operations in New Zealand have been chiefly confined to Otago, but recently attention has been turned to the West Coast, where many claims have been pegged off and dredges are in course of construction for them. Some of these claims are very rich, but rough, and consequently will require very powerful machines.

So far this article has dealt only with dredging as it is carried on in

river claims. There is, however, another branch of the industry which is attracting a great deal of attention, viz., dry-land dredging as it is termed—that is to say, the dredging of auriferous alluvial flats and ancient river beds. In such claims thorough prospecting by means of boring is simple and is easily accomplished before going to the expense of a dredge. The exact nature of the ground to be worked, the depth of the wash, and the richness thereof can be ascertained to a nicety. Want of water is often a serious drawback to such ventures, but where a small creek or stream is available and a dam is built, this difficulty is overcome. One great advantage which dry claims possess over river claims lies in their immunity from floods in spring and summer time, often the cause of temporary delay to river dredging. The Evans Flat and the Tuapeka dredges are both working old alluvial diggings with satisfactory results. Both machines are good examples of their class, being small, well built, and inexpensive to work. Cost of construction in each case was under £2,500, and their present average returns are about 25 ozs. each per week, while their working expenses are covered by 7 ozs. per week. Notwithstanding the success of dredging in Otago, the dredge of to-day has by no means reached perfection, and there remain many difficult engineering problems to be solved before a certain class of claims can be considered thoroughly worked out and all payable gold therein extracted. Take, for example, a gorge claim

McEachen, Photo., Alexandra.

A PORTION OF THE HARTLEY AND RILEY CLAIM.

DREDGE BUCKETS. THE PAST AND PRESENT IN NEW ZEALAND.

situated on a swift running river like the Molyneux. The bottom may be rocky and uneven, and with the present style of round-lipped buckets, however large, it is impossible to secure the heavy gold which lies hidden in the crevices and holes of the bed rock. Years ago, before dredging was thought of and when the river was comparatively free from drift, the miners took many pounds' weight of gold from seams and cracks in the rock-bound claims, following these cracks down until it was impossible to venture further. To-day these same fissures lie hidden under 20 ft. of drift, which covers up untold quantities of the precious metal and only waits some ingenious engineering contrivance to bring the gold to light.

The invention of the suction dredge, would, it was thought, make the dredging of rough-bottomed claims an entire success; but, although twenty dredges of this description have been placed upon claims in New Zealand, none of them has proved a financial success.

During the next twelve months we may reasonably expect to see a considerable expansion of the dredging industry, as in that time many machines now in course of construction will be at work.

The returns have proved, and are proving, so satisfactory that the public are readily subscribing a large amount of capital, the result being a tendency to build larger and more powerful dredges, capable of dredging to greater depth than formerly, and also of lifting and treating a larger quantity of wash dirt.

THE PROBLEM OF COALING WARSHIPS AT SEA.

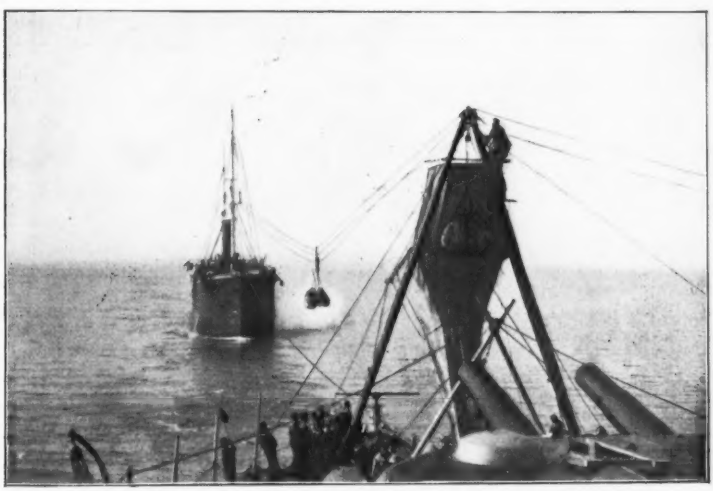
By Spencer Miller.

ON May 24th, 1898, the following telegram was sent from Admiral (then Commodore) Schley to Admiral Sampson: "Coaling off Cienfuegos is very uncertain. Having ascertained that the Spanish fleet is not here I will move eastward to-morrow, communicating with you from Nicholas Mole; on account of short coal supply in ships cannot blockade them if in Santiago. I shall proceed to-morrow, 25th, for Santiago, being embarrassed, however, by Texas' short coal supply, and our inability to coal in the open sea. I shall not be able to remain off that port on account of the general short coal supply of squadron, so will proceed to vicinity of Nicholas Mole, where the water is smooth, and I can coal the Texas and other ships with what coal may remain in collier." Probably no message was ever received by the U. S. Navy Department which more thoroughly emphasized the importance of an apparatus which would coal vessels at sea. One year and a half later an experiment was made off Sandy Hook with an apparatus to coal at sea which gave rise to a remark by Captain C. J. Train, of the U. S. S. Massachusetts, who had just witnessed a day's rough-weather trial of the apparatus; he said: "There was no time during the Cuban blockade of last year when this system could not have been used. I consider it a great success. It proves the system capable of supplying coal in almost any weather that is fit to coal ship."

Admiral Schley's message of desperation was written while attempting to bottle up the only Spanish fleet present in American waters. It is difficult to imagine what might have been dispatched if the "Flying Squadron" had visited the coast of Spain. Imagine a fleet arriving off the enemy's coast, with its coal bunkers practically empty, and unable to coal at sea. The advantage would lie with the

enemy, putting out from home ports with bunkers well filled. The programme would be, of course, first to capture a base where colliers could lie and warships have their bunkers replenished. But the capture of such a base might result in the loss of a ship, and, even though it did not, the campaign of attack would be hampered by the necessity of maintaining a defense of the colliers, especially against torpedo-boat attack. This point is made doubly important since the submarine torpedo-boat has proved a success. In contrast to this, imagine that each collier is fitted to coal at sea and under headway. Not only would the attacking fleet arrive with bunkers filled, but the colliers, being able to remain at sea, would stand less in peril of torpedo attack.

The late Vice-Admiral Colomb recently said: "The superior American navy makes no attempt to carry the war into European waters as Great Britain in 1812-14 carried it into American waters. It is incapable of watching European Spanish ports, and Spanish ships are free to come and go out of them as though there were no war. The American ships, arriving on the Spanish coast, could not begin the blockade of Cadiz until they had filled up with coal, and that coal must either have preceded them or have been brought over with them in colliers.



THE MILLER CONVEYOR FOR COALING AT SEA, INSTALLED BY THE LIDGERWOOD MFG. CO.

The view, taken during the smooth water tests, shows the quarter deck of the Massachusetts with shear poles and chute, the collier Marcellus in tow, and the sea-anchor conveyor lines with coal bags in transit. The man at the shear head hooks the empty bags on to the returning carriage.

Again, Vice-Admiral Colomb said: "Cervera steaming past Martinique might have steered straight for Santiago, might have sent a destroyer in for intelligence, and might have gone on to strike his blows as indicated. Why did he let his whereabouts be known at Martinique when he might have run past at night and nobody the wiser? Why did he again show himself at Curaçao, and why did he pass into Santiago without attempting anything? The only plain reason we can adduce for what took place is the question of coal supply."

The importance of the question increases directly as the increase of sea-power, and with the probability of fighting naval wars far from home shores the ratio rises enormously. England's first line of defense is said to be the enemy's coast. She is well supplied with coaling stations all around the world. But, were she blockading foreign ports, how large a portion of the blockading fleet would be worse than ineffective, because itself subject to possible attack by superior force while steaming between blockade and coaling station? The greater the distance to the coal, the greater the number of vessels continuously off station, and, with Guantanamo only forty-five miles away, only three-fourths of the American ships could be kept actually on blockade service. Germany fully appreciates the necessity of an apparatus for coaling at sea, as indicated by the statement of Rear-Admiral Pluddeman, who said recently: "It will be absolutely necessary in future to take coal from a collier at sea."*

Nor is the desirability—nor, I believe, the possibility—of mechanical transport from ship to ship confined to the transfer of coal. Why can not provisions and ammunition be also transferred from one ship to the other at a safe distance? And does not this possibly indicate a new type of ship for the use of navies, which might be called a "general-supply ship, carrying in its hold everything a warship needs, and equipped not only to transfer its cargo at sea, but in port as well?

The problem of building a marine cableway is one that has received a great deal of attention for a number of years.† The first suggestion of such a device was made by Lieutenant Bell, of the British navy, in 1887, and his plan involved the use of a suspended cable, running from a mast on the stern of the warship to the foremast of the collier in tow, and used for the transferring of coal. This apparatus was never tried, for it was appreciated that it would have utterly failed, as Lieutenant Bell had made no provision for the relative motion of the

* Notes published by the U. S. Bureau of Naval Intelligence, Washington, Dec., 1898.

† For a full review of the history of coaling vessels at sea, including amplified explanation of the devices here described, see the author's paper before the Society of Naval Architects and Marine Engineers, N. Y., Nov. 16-17, 1899.

boats. No such apparatus will ever succeed in coaling at sea that does not involve in its design some sort of compensating device, whereby the suspended cables are held under uniform tension in spite of the pitching and tossing of the vessels. The same criticism applies to the scheme proposed by Lieutenant R. G. O. Tupper, R. N., which, in substance, contemplated the use of an endless rope, with suspended buckets of coal at frequent intervals, operated by a capstan.

As I am dealing wholly with the problem of open-sea coaling, and not with harbor or smooth-water operations, I need make no mention

STERN VIEW OF THE U. S. S. MASSACHUSETTS COALING AT SEA.
She is towing the collier at a speed of six knots. The load—840 lbs.—is going toward the warship at a speed of 1,200 ft. per minute.

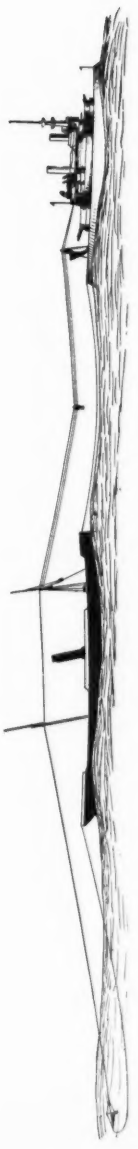
of the Temperley transporter, so largely used in the British navy, nor of any other plan involving side-by-side positions. Vessels cannot be brought broadside-to, even in the most moderate sea.

The first experiment tried by the United States war vessels was that of Philip B. Low, and the trial was made in 1893, when an inclined cable, attached to shear poles on the towing vessel and led over a "gin block" at the masthead of the collier, was held under tension by a counterweight moving up and down between the deck and the mast-

head. The loads traveled by gravity from collier to warship. The plan patented by John E. Walsh, of New York, while more elaborate, also depends upon a counterweight to compensate for the irregularities caused by the diverse pitching and rolling of the ships. Such a compensator may work in a smooth sea, and the device may transport a small amount of coal, but the experience gleaned in the recent experiments off Sandy Hook proves conclusively that such a device would be a total failure in seas of any magnitude. One little experience alone will demonstrate that. During the operation of transferring coal on December 23, 1899, the tow line suddenly slipped, and before it could be secured some forty feet had been paid out. Such a slip, with a counterweight at the end of the cable, would probably have resulted in breaking the cable, followed by the falling of the counterweight, or else the unshipping of the foremast. In the apparatus tested this slip was not even noticed by those on the Massachusetts, the lines instantly adjusting themselves.

Just before the breaking out of the Spanish-American war, in March, 1898, Mr. J. J. Woodward, naval constructor, U. S. N., located at Newport News, Va., sent to the Lidgerwood Manufacturing Company, of New York, an outlined plan for coaling a warship from a collier in tow, by means of a suspended cable, asking for a plan and a proposal. He foresaw the experience indicated in Commodore Schley's letter. His inquiry was referred to the author, who immediately set to work in earnest to design an apparatus to fulfill the conditions specified. On May 11, during the war, a proposal was laid before Admiral Bradford, chief of the Bureau of Equipment of the United States navy, which proposal and its accompanying plans were referred to a board which Secretary Long had especially appointed to consider devices for coaling at sea. On May 20th the board brought in an adverse report, whereupon the plans were revised, and again submitted to the same board on June 17th. This plan was promptly considered and reported upon to be "feasible in moderate weather." Although the navy department at that time had full knowledge of the difficulties encountered by Commodore Schley, it still required several weeks to obtain from the department such a contract as the builders could or would proceed to execute. On July 22d the proposal was accepted, and the collier Marcellus was named to be fitted with the apparatus.

The sudden termination of the war made unnecessary the hurried execution of the contract that had been anticipated. The apparatus was not completed until November 20, 1898, The collier Marcellus was then needed for service, hence the apparatus was not installed until Septem-



U. S COLLIER MARCELLUS DELIVERING COAL AT SEA TO THE U. S. S. MASSACHUSETTS.
Towing speed five to six knots; loads 840 lbs.; conveyor speed 1,200 ft. per minute; actual capacity 20 to 24 tons per hour.

ber of the following year. During the spring months of 1899 the apparatus was set up on land, perfected, and several demonstrations were made before naval officers, whose opinions were sought as to the practicability of the apparatus. Among these were Rear Admiral W. T. Sampson and Commander Raymond P. Rodgers, both of whom expressed a most favorable opinion of the apparatus, and Naval Constructor F. T. Bowles, of the New York navy yard, who did not hesitate to say, when asked by the then acting secretary, the Hon. Charles H. Allen, that the apparatus in his opinion would fully meet the requirements of the contract.

The contract with the department specified that the apparatus should safely transfer coal in bags from collier to warship at a rate of not less than 15 tons per hour, in a moderate sea and weather, and with a distance not less than 300 feet between ships.

The apparatus in its final trial transferred over 20 tons of coal per hour, in a sea a little heavier than moderate, with a distance of about 400 feet between the ships.

An engine, (see page 717), with double cylinders and double friction drums of special design, was located just abaft the foremast of the collier. It had two steam cylinders 12 in. by 12 in. A ¾-in. diameter steel rope was led from one drum over a pulley at the masthead, and thence to a pulley at the head of shear poles on the warship and returned to the other drum.

The engine moves in the same direction all the time and tends to wind in both parts of the conveying rope. One drum hauls in its part of the rope and the other pays it out under tension by the slipping of the drum. A novel form of load carriage is supported by this rope. It is provided with a grip on the upper part and wheels to run on the lower part. This carriage carries two loaded bags weigh-

ing 420 lbs. each, suspended from a bale which hangs in a hook below the carriage. An elevator takes the bags from the deck, hoisting them to the masthead. The conveyor carriage, in coming in to the masthead, locks itself under the bale. As soon as the bale is released (by a man stationed on the trestletrees) the engine

CARRIAGE WITH LOAD OF 840 LBS. IN TRANSIT.

The upper rope is the sea-anchor line; the two lower ropes are the conveyor line.

operator hauls in the lower part of the conveyor line. The upper part of the conveyor line is thereby drawn from the rear drum, slipping the specially contrived friction devices. Thus the carriage crosses from collier to warship, the tension being sufficient to insure the bags clearing the water between the vessels. The rope is drawn in at a speed of

FORECASTLE OF COLLIER MARCELLUS, DELIVERING COAL AT SEA TO U. S. S. MASSACHUSETTS.

Two bags are shown in transit. The elevator on the collier is descending with empty bags.

ENGINE FOR THE MILLER CONVEYOR SYSTEM.

Cylinders 12x12; drums 36-in. diameter; speed of rope 1,000 to 1,500 ft. per minute. The forward winch is used for hoisting the bags on the elevator to the masthead.

1,000 ft. per minute, and, if the points of support (masthead and shear head) do not vary, the upper part will be drawn out, under tension of about 3,000 lbs., at the same rate of speed. If, however, the distance is increased during the transit of the load, the extra rope called for will be given by the slipping of the upper part from the drum. This will increase the speed of the upper part. On the other hand, if the ships reduce the distance between points of support, the speed of the upper part will be reduced.

Thus, it will be observed, speed is an element of compensation. The speed, therefore, must be more than twice that at which the points of support can approach or recede from one another, in order to compensate perfectly for the relative motion of the ships.

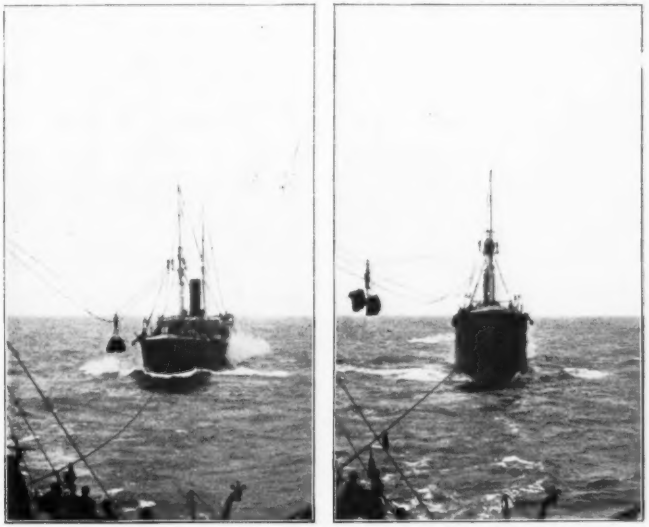
When the carriage reaches the pulley at the shear head it collides with it (at reduced speed of course) and thus striking, releases the lower hook, and the two bags and their bale drop into the canvas chute and slide easily to the deck of the warship. Loads drop in this manner at the rate of one per minute. The empty carriage is drawn back by the rear drum, the forward drum being thrown out of friction.

An auxiliary rope known as the "sea-anchor line" is stretched above the two parts of the conveyor line and under a pulley on the carriage. This rope is attached by a "knock-off hook" to the superstructure of the warship, and rests in a "saddle" on the shear head; thence it leads through the carriage, over pulleys at the head of the foremast and mainmast of the collier, and on astern several hundred feet to the sea. On the end of this rope, a drag or "sea anchor" is attached, made of canvas in the form of a cone. This sea anchor is selected in reference to the speed with which the ships are to travel. In a smooth water test, speeding at six knots, a drag 7 ft. in diameter at the base was used. During the rough-weather trial, the same anchor seemed to give the required tension at five knots.

This line is to support the carriage when empty, on its return to the collier. It permits the conveyor line to be slack and prevents the overturning or twisting of the carriage. Doubtless at times it helps also to support the load in transit across, but photographic views, taken during the passage of the load, show the sea-anchor line slack, thus demonstrating that the tension device on the conveyor line is sufficient to sustain the load at a sufficient elevation during its transit.

About twenty men on the collier fill the bags and deliver them to the forward deck, and sixteen more take the bags to the elevator. In order that the operation may be carried on continuously the empty bags must be returned. This is accomplished by stationing two men in

"crows' nests" at the shear head of the warship to hook the empty bags onto the side hooks on the carriage. Two other men at the masthead of the collier receive the bags. These are then placed on side hooks of the elevator and sent to the deck. The entire operation is continuous, and no delay is caused by hooking on or unhooking the bags.

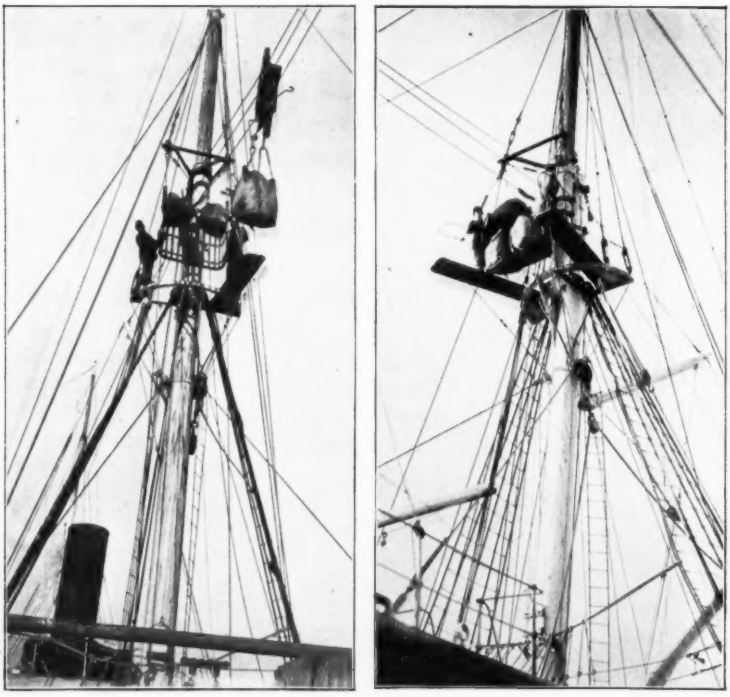


COALING IN A HEAVY SWELL. SPEED 6 KNOTS. HOURLY CAPACITY 21 TONS

On the left the Marcellus is plunging; the loaded bags are in transit to the warship. On the right the Marcellus is rising; the sea-anchor line is taking the weight of the carriage with empty bags.

At 300-ft. distance between the ships, even in smooth water, the collier Marcellus followed badly, and when over 7 degrees out of her course the operation was stopped. In spite of stops, however, 20 tons per hour were delivered. During the rough-weather trial, however, and with about 400 ft. between the ships, the collier followed perfectly, and no time was lost.

The apparatus had five sea trials. On the first day adjustments were made and 9 loads only were sent over. On the second day more adjustments were made, and a run of 38 loads in 38 min. and 40 sec. was suddenly terminated through the lack of skill on the part of the operator, who allowed all the rope to be coiled on the forward drum. This slipped the clip on the end of the rope through the other drum and the rope fell into the sea. No damage was done, no one was hurt,



AT THE MASTHEAD OF THE COLLIER.

In the view at the left, the carriage with suspended bags is just leaving the elevator on its journey to the warship. At the right is shown the elevator with loaded bags waiting for the conveyor carriage. The man on the platform takes off the empty bags on the returning carriage.

and the only penalty of such an accident was an hour's delay in rigging up again. On the third day, in one hour the apparatus transferred about 22 tons, and the work would have been continued longer but for lack of sufficient crew to fill the bags.

The navy department then ordered an endurance test of not less than four hours' duration, and a rough-weather trial as well.

Between the third and fourth trials some trifling alterations were made. The fourth trial lasted four hours. 75 tons were handled in 3 hours and 43 min. The water was smooth, with a ground swell. In the fifth test—the rough-weather trial—80 trips were made in 80 minutes. The performance could have been continued for an indefinite time, but the board being satisfied, there was no object in going

further. One hour and a half was consumed in securing the tow line and setting up the apparatus.

The boats steered at first head on to the sea. The forecastle of the Massachusetts was washed at every plunge, and no coal could have been delivered there, even if desired. A little more than 20 tons were handled in an hour. The course was then changed quartering on the sea, and the results were the same. Then the boats steered in the trough of the sea and the rolling did not affect the working. The speed was maintained at about five knots. The Massachusetts burned about 3½ tons of coal per hour during the trial, thus gaining 16½ tons.

It must be borne in mind that it was a naval man, Naval Constructor J. J. Woodward, who requested plans for a marine cableway to coal at sea. He saw that the problem was that of modifying the cableway to fit sea conditions. The engineer, designing an apparatus to meet a new condition, must need to consult men versed in the field in which such device is to be used. So the designer of this apparatus, a landsman, sought the advice of many naval men, notably Chief Engineer Robt. Potts (retired), U. S. N., and Mr. F. T. Bowles, naval constructor, and Mr. Wm. Anderson, chief boatswain. Mr. Anderson, by permission of Assistant Secretary Allen, was employed to take charge of the trials, and his handling of the device and the men was so satisfactory that the designer had nothing to say during the last two trials.

Captain C. J. Train, of the U. S. S. Massachusetts, offered every assistance in his power to secure for the device a fair and sufficient trial. The same may be said of all the officers of both ships. The trial board, consisting of Commander A. B. H. Lillie, Lieut. John B. Bernardou, Lieut. W. R. Rush, and Warrant Machinist Biggs, also showed the greatest attention to all the details of the device, and their report is a faithful account of the trials.

Eleven ships were blockading Santiago—but when the Spanish fleet came out three were absent off station "coaling ship." They were at Guantanamo, 45 miles away. In the United States civil war, one-quarter of the vessels blockading Charleston, S. C., were alike away continuously coaling in smooth water. Thus we see, at Santiago, $5,000,000 worth of United States war vessels useless at the great crisis—and all because the colliers could not deliver their coal at sea. Can it be disputed, therefore, that the fighting efficiency of a blockading fleet will be increased by one-third, if waited upon by colliers capable of coaling at sea?

THE PRODUCTION AND UTILIZATION OF SUPERHEATED STEAM.

By R. S. Hale.

THE simplest and most usual method for producing superheated steam is to expose the saturated steam in a suitable vessel to the heat of the gases from the furnace, and practically any form of vessel can be made to serve for this, just as any form of vessel will serve as a boiler, and the qualities that make a good superheater are much the same as those that make a good boiler.

There are, however, a few points about superheaters that require special consideration in addition to the usual considerations governing boiler design, and the most important of these is the question whether the superheater should be located directly over the furnace, in the flue, or in an intermediate position. The old-fashioned method was to place the superheater in the flue exposed to the waste gases, and this position has the advantage that there is but slight danger of injuring the superheater by over-heating. On the other hand, placing the superheater in the path of the waste gases requires a very large area of superheating surface, since the waste gases are already comparatively cool, and cannot be cooled by the superheater below the temperature of the superheated steam; the combination of the boiler with the superheater in the flue is, therefore, an inefficient one for the production of steam. Further, this position of the superheater makes the temperature of superheat comparatively irregular, and in consequence of these objections the trend of the best practice of to-day is decidedly against placing the superheater in the path of the waste gases. Instead, considerable progress has been made toward the adoption of the position which seems theoretically best for the superheater in order to make the combination of boiler and superheater most efficient, viz., directly over the furnace fire, so that the hottest steam, which is the superheated steam, shall be exposed to the hottest gases. Since the furnace of the boiler itself would be so hot as to burn the superheater, a separate furnace for superheating must be provided, and such a furnace, besides being inefficient on account of its small size and of the high temperature at which the gases must leave it, is also comparatively expensive, since it is a special installation, and requires special attention and care in order to keep the temperature of superheat uniform. As a consequence, neither the path of the waste gases nor the

separate furnace appears to be as advantageous a place for the superheater, in practical work, as the intermediate position. For example, if a superheater for a Babcock & Wilcox boiler is placed between the tubes and the drum, the gases surrounding the superheater are sufficiently cooled by the first pass through the tubes to avoid serious danger from over-heating, and are yet so hot that but a comparatively small area of superheating surface is required. Then, after the gases have been utilized for superheating, their heat is further utilized by the remainder of the boiler-heating surface, so that the combination of a boiler and a superheater in this position is as efficient for the utilization of the heat of the coal as a boiler alone—in fact, more efficient. It is clear, therefore, that this position is in general the best one, although, of course, special considerations may make the separate furnace or the location of the superheater in the flue better for some plants.

Another special consideration appertaining to superheater design, as distinct from boiler design, is the need of a very swift circulation in types of superheater that are exposed to very hot gases, because of the possibility of overheating. Although the velocity of the steam is usually sufficient when the boiler is working, yet when steam is being raised there is no circulation in the superheater, while at the same time it is surrounded by very hot gases. It is therefore necessary with some types of superheater to provide means for flooding the superheater with water while steam is being raised. With other types of superheater this does not appear to be necessary.

Other questions of superheater design differ but slightly, if at all, from the questions that come up in boiler design proper, a fact which is brought out by a comparison of the different forms of superheater with well known boiler types. For instance, we have the old-fashioned steam chimney for superheating, corresponding with the old-fashioned shell boiler without tubes. The Gehre superheater is built almost exactly like a fire-tube boiler. The Uhler superheater consists of Field tubes, *i. e.*, one tube inside of and concentric with another, a form of construction that has often been used for boilers. The superheaters on the U. S. SS. Georgeanna and Adelaide, described in Isherwood's "Researches of Steam Engineering," correspond to the water-tube boilers using straight tubes, while the Musgrave and Dixon superheater, or its practical equivalent, the Babcock & Wilcox, uses U-tubes expanded into cross-boxes, and corresponds to the various water-tube boilers using bent tubes.

Outside the patent-office records, the only superheater of to-day that differs markedly in design from any type of boiler is the

Schwoerer. This superheater consists of heavy cast-iron tubes, ribbed externally and provided internally with transverse baffle-plates. The use of cast iron at high temperatures and high pressures is a marked innovation, but the use of very thick metal appears to give absolute safety, since it is reported that these superheaters have been run red-hot without sign of trouble, and certainly the reports of the boiler-insurance companies in France and Germany, where these superheaters are used, seem to show no difficulty with them. So far as I can learn, this superheater is not injured if the steam is delivered directly to the pipes without passing through the superheater, in case it is desired not to use the superheater on account of injury or other reason, while with most superheaters (except, of course, those in the flue or over a separate furnace) the superheater will be spoiled unless steam is kept passing through it at all times when the boiler is in service. Its use would enable the boiler to be tested with and without the superheater in operation, a thing that would be impossible to do, without injury, with other types of superheater when placed in this position; it would also prevent injury if steam is raised without flooding the superheater. The ribbed surfaces and the internal baffle-plates make the tubes very efficient for the transferring of heat, so that a small superheater is effective in superheating a large quantity of steam.

While superheating by means of the gases is the simplest and most usual method, two other methods have been proposed, to which brief reference may be made. One of these methods consists in generating steam at high pressure and then superheating it by wire-drawing it to a lower temperature. For instance, steam might be generated at 500-lbs. pressure and then wiredrawn to 150 lbs. It is not necessary to give the calculation, but it suffices to say that the maximum superheat to be thus obtained is only about 70° F. if the steam is absolutely dry, whereas if there be only 3½ per cent. moisture in the steam at 500 lbs., the heat which would otherwise superheat the steam serves to dry out this moisture and practically no superheat will be obtained. An initial pressure of 500 lbs. is an extreme case, and in the case more ordinarily proposed, of generating steam at, say, 200 lbs. and then wiredrawing it to 150 lbs., the superheat obtainable will be only 20° if the steam is dry, and none at all if the steam contains 1 per cent. or more of moisture. Now, since high-pressure boilers are more expensive to build and less efficient in operation than low-pressure boilers, it is clear that it will not be good practice to generate steam at a high pressure and then to wire-draw for the sake of obtaining such a slight degree of superheat at a lower pressure.

Another very interesting method of superheating steam is described in some British patents of recent years. In consists in passing the steam through coils of pipe surrounded by a liquid of high boiling point, as, for instance, mercury or oil. The liquid is heated by a separate furnace or by the boiler gases, and it is obvious that none of the apparatus can rise in temperature more than a few degrees above the boiling point of the liquid, a fact which makes the apparatus safe from over-heating, while the superheated steam will be given a regular temperature. While this method gets rid of the difficulties inherent in any apparatus which has hot gases on one side and hot steam on the other, it does not appear ever to have been put into practical operation. Possibly the difficulty has been to find a suitable liquid, since mercury would be too expensive and any oil would be subject to the danger that it might give off explosive gases. High-pressure steam might be used as the liquid, but this would introduce the difficulties of generating and handling high pressures, although it would have the advantage over ordinary superheaters that it would avoid the necessity of having a vessel with hot gases on one side and hot steam on the other, since the high-pressure generator need not have any superheating surface. If, however, the high-pressure steam must be generated in any case, the method appears to be a good one, and, in fact, high-pressure boiler steam is the vehicle used for superheating the low-pressure steam in the receivers of a compound or triple-expansion engine.

It is clear, therefore, that the simple and direct method of utilizing the furnace gases by a superheater placed in the first pass of the gases, where they have been cooled sufficiently to avoid danger of over-heating the superheater and are yet so hot that only a small area of superheating surface is required, will probably represent in the future, as it does now, the best practice of superheating high-pressure steam, while high-pressure saturated steam itself will be the best means for superheating low-pressure steam. In regard to the type of superheater to be used, it will probably be many years before we shall be able to say that any one type—the Musgrave and Dixon, the Gehre, the Babcock & Wilcox, or the Schwoerer—is the best, any more than we can to-day say that any one type of boiler is better than another. Some types of superheater now used will be found impracticable and new types will appear, but the choice between the types will depend on their first cost, on the cost of their maintenance, and on their freedom from trouble in practical operation—questions which cannot be decided by any theoretical considerations.

We may, therefore, take up the second branch of our subject, the

utilization of superheat, and before discussing the saving to be expected when superheated steam is used in an engine, it will be well to point out that superheated steam for heating purposes has no practical advantage. It is true that when first turned into the pipes it is hotter than saturated steam, but it loses this extra temperature and becomes saturated steam of lower temperature in a very few minutes. It is more expensive to produce than saturated steam and may give rise to difficulties on account of its irregularities of temperature, so that it is safe to say that it should never be produced for heating purposes.

The chief, and practically the only, use of superheated steam is in engines, and here the superheat operates to diminish the waste known as initial condensation—a waste caused by the cold walls of the cylinder. The amount by which superheat reduces this loss has varied greatly in the different experiments. Isherwood, in his "Researches of Steam Engineering," volume 2, preface page 28, states the saving as 33 per cent. for 135° F. superheat, or a gross saving of 5 per cent. for each 20° F. superheat. Thurston, Transactions of the A. S. M. E., 1896, page 551, gives the average saving of fifty-two tests as 26 per cent. for an average superheat of 105° F., or 5 per cent. for every 20° F. It is not clear whether this is the gross saving or whether it is the net saving after allowing for the 1 per cent. extra heat required to superheat steam each 20° F.* Barrus, Boiler Tests, page 23, gives the gross saving as 2 to 3 per cent. for each 20° F. A number of recent German and French tests averaged 3 per cent. for each 20° F. The average of the five tests actually quoted in Thurston's paper above referred to, is 4 per cent. for each 20° F. Ripper, Proc. I. C. E., 1897, gives some very careful experiments showing a gross saving of from 3.2 to 3.6 per cent. per 20° F. In all the cases, the per cent. saving is taken of the quantity of saturated steam used, *i. e.*, of the larger quantity.

The superheat in these experiments ranged from a few degrees to 350° F., and the saving per 20° F. appears to be about the same for all degrees of superheat. This is contrary to the usual idea that the proportionate saving is greater for small degrees of superheat, but the experimental evidence points strongly towards the saving being proportionate over the whole range from no superheat to 350° F. superheat. It is possible that the idea that the first few degrees of superheat are of special advantage arose from experiments in which steam superheated a few degrees was compared with saturated steam containing

* Of course this figure is approximate.

moisture which was not allowed for. Of course, if the moisture in the saturated steam is not allowed for, the saving per 20° F. will be abnormally large for small amounts of superheat.

The average of this large number of experiments is almost exactly 4 per cent. gross gain for each 20° F. superheat, or a net gain of 3 per cent. after allowing for the 1 per cent. of heat necessary to superheat steam 20° F. This is probably a safe average figure, although, of course, an average figure does not necessarily represent any particular set of conditions. It is clear that the saving exists, and in spite of incidental losses when superheated steam is used, such as extra radiation and extra leaks, it is almost certain that there are many plants where superheated steam will pay a good net return on the first cost of the superheater. It is also clear that, up to a limit of 675° F. temperature, the higher the temperature of the steam, the greater will be the total saving.

In the discussion of methods of superheating above given, reference was made to the use of coils surrounded by high-pressure boiler steam for the purpose of superheating low-pressure steam in the receivers of a compound or triple-expansion engine. The figure just given as the probable saving for each 20° F. of superheat may probably be used safely in computing the saving obtained by superheating receiver steam in this manner. Let us assume that we have a compound engine taking saturated steam at 125-lbs. pressure, or 350° F., doing the same amount of work in each cylinder, and using 15 lbs. of steam per i.h.p. per hour. Each cylinder, therefore, may be considered a simple engine using 30 lbs. of steam per i.h.p. per hour—or, putting it in another way, each 300 lbs. of steam that goes through the engine does 10 h.p. in the high-pressure cylinder and 10 h.p. in the low-pressure cylinder. Now, let us assume that the steam in the receiver has a pressure of 15 lbs. The temperature of saturated steam of 15-lbs. pressure is 250° F., but, if the receiver steam is superheated by jacketing it with boiler steam, it may be raised to 350° F., the temperature of the boiler steam, which makes a superheat of 100° F. This will require approximately 5 per cent. more heat, or, instead of the 300 lbs. of steam per hour, it will require the boiler to deliver 315 lbs. of steam per hour. The gain, however, due to a superheat of 100° F. in the low-pressure cylinder, will be, according to the figure given above, approximately 4 per cent. for each 20° F., making 20 per cent. for the 100° superheat. The low-pressure cylinder, therefore, will be working at a water rate of 24 lbs. per h.p., instead of 30 lbs., so that the 300 lbs. steam will do 12.5 h. p., instead of

10 h.p. in the low-pressure cylinder. The net result, therefore, is that if we superheat the steam in the receiver we shall get 22.5 h.p. for 315 lbs. of feed water per hour, or a rate of 14 lbs. per h.p., instead of 15 lbs. per h.p. without superheating between the cylinders—a net gain of approximately 7 per cent. The same thing would hold true if the steam were superheated in the receivers of a triple-expansion engine, only the gain would be greater.

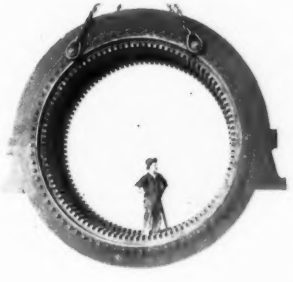
While the superheated steam shows these large savings, it is interesting and important to note that the saving is due to the higher temperature of steam at the same pressure, *i. e.*, steam superheated 100° F. shows a saving only when compared with saturated steam of the same pressure, which is 100° F. cooler. If, however, steam superheated 100° F. be compared with saturated steam of the same temperature (and consequently higher pressure), it actually shows a loss. For instance, take the case of the compound engine discussed above. The low-pressure cylinder, considered alone, has a water rate of 30 lbs. per h.p. for saturated steam of 15-lbs. pressure and 250° F. temperature, and a water rate of 24 lbs. per h.p. for steam of 15-lbs. pressure superheated to 350° F. Against this we have the fact that saturated steam of 350° F. (which would have 125-lbs. pressure) will give a water rate of 20 lbs. in a single-expansion engine, or 15 lbs. in a compound—a better rate than can be obtained by superheated steam of any pressure, unless the temperature exceeds 350° F.

The use of higher and higher steam pressures and temperatures has been advancing rapidly of late years. The obstacles to this advance have been largely obstacles due to temperature, and the ultimate limit to the increase is probably the limit of temperature where metals lose their strength, since in hydraulic and compressed-air work, where the difficulties of temperature do not enter, pressures of 1,500 and 2,000 lbs. are in practical use. It is possible, therefore, that some day (when accident insurance is cheaper) we may use steam pressures so high that the temperature of the saturated steam cannot be raised without danger of weakening the metal, so that superheat will no longer be available. This day, however, is far in the future, since we can use, and are using to-day, temperatures of 650° F., while steam of 500 lbs. has a temperature of only 467° F. and can be superheated 200° F., with a saving of 30 per cent., and steam of 1,000-lbs. pressure has a temperature of 546° F. and can be superheated 100° with a saving of 15 per cent. Steam of 500-lbs. pressure superheated to 650° F. may seem a good deal of a problem, but I believe it to be one of the probabilities of the future.

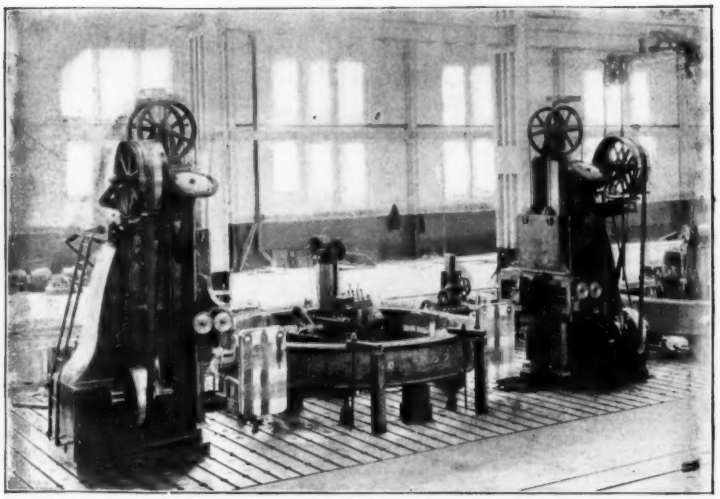
THE REVOLUTION IN MACHINE-SHOP PRACTICE.

By Henry Roland.

V.—THE APPLICATION OF AUTOMATIC MECHANICAL PRODUCTION TO HEAVY WORK.



THE evolution of automatic and semi-automatic machine tools has naturally been limited, as shown in the preceding articles of this series, to work of comparatively small dimensions, sizes up to 10 or 12 ins. diameter having been about the largest handled so far, and no great effort has been made to place the finishing of heavy work in lathes, planers, boring mills, and traversing-spindle milling, drilling and boring machines of large dimensions in charge of specialized laborers. The flexibility of both cast iron and wrought steel, in large dimensions, makes skill and experience in setting and supporting large pieces in process of machine-tool finishing indispensable. In work of small dimensions, this factor of structural flexibility is so small that it need not be reckoned with; in work of large dimensions it must be anticipated and guarded against at every step and stage of machine tooling, if oval and eccentric lathe work and distorted finished plane surfaces are to be avoided in the completed pieces. It is true that the setting of large pieces in machines other than lathes has been very greatly facilitated by slotted sole plates of large dimensions, very carefully supported on ample foundations, in the case of the traversing milling and boring machines, and that work can be set on tables of the vertical boring mills with a far less expenditure of skill and labor than is required to support the same pieces securely and accurately on the large-lathe face plate; it is also true that, in the case of the special cylinder-boring machines which are mentioned hereafter in this paper, parallel and right-angle boring of holes in the same piece is assured by the introduction of separate added boring spindles; but great care, great skill, and great experience are required on the part of the workman to avoid distorting the



AN INSTANCE OF THE USE OF SLOTTED SOLE PLATE AND PORTABLE MACHINES IN THE PRACTICE OF THE GENERAL ELECTRIC COMPANY.

On the right and left are portable slotters, in the center a portable drill press, all electric driven. The tools are arranged for simultaneous working on heavy machine parts.

work by clamping it, or by failure properly to support it against the heavy cuts of the tools; besides this, the large cost and great importance of these large machine tools makes the item of a difference of a dollar or so a day in the attendant's wage a matter of small import, and there is no indication that large general machine tools can be successfully given in charge of any but the best and most experienced mechanics obtainable.

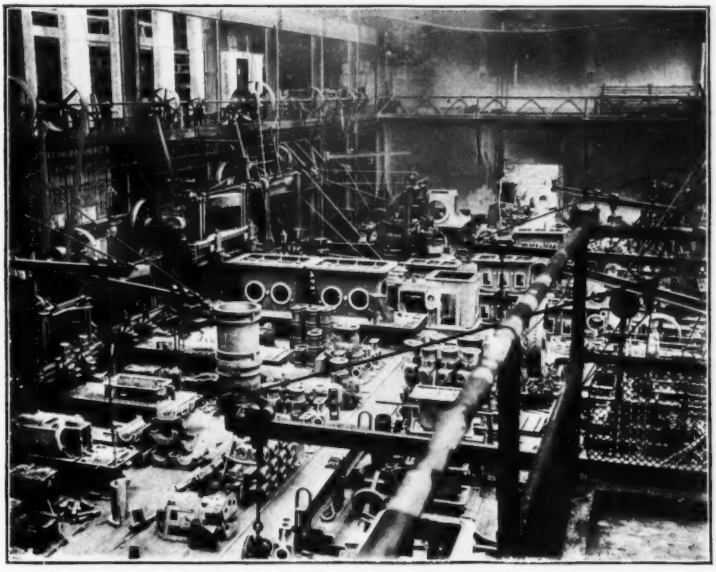
Another great barrier to the rapid spread of such practice is the commercial one. There are as yet but a limited number of cases affording opportunity for manifold exact repetitions of heavy machine parts. The progress of special tool-making must go step by step with that of the standardization of heavy work. At present it is, in American shops at least, probably quite as far advanced as the conditions of mechanical manufacture demand.

An example of the great differentiation which yet exists between light, or even medium, and heavy work, and a test of the correctness of my general conclusions as to ultimate machine-shop methods, is afforded by the inspection of advanced practice in machine-constructing which I recently had the opportunity to make in the Westinghouse

shops. The contrast of methods and means is especially striking when it is made between the Westinghouse Air-Brake Company's works at Wilmerding and the Westinghouse Machine Company's establishment at East Pittsburg.

The limits of this paper forbid more than the briefest mention of a very few of the most striking peculiarities of the brake-shops practice, which is exactly in line in all essential particulars with my own conclusions and theories. Of the two thousand hands employed in the construction of work requiring fully the accuracy of good steam-engine construction, only about 10 per cent. are skilled mechanics. Work is produced in both the foundry and the machine shops at extremely low labor-hour costs, and the whole machine-shop special-tool equipment was constructed by well known makers, little or none of it being of home manufacture. The foundry is operated on an amplification of the turret scheme, endless chains of carriers about 230 ft. long being employed to perform most of the work.

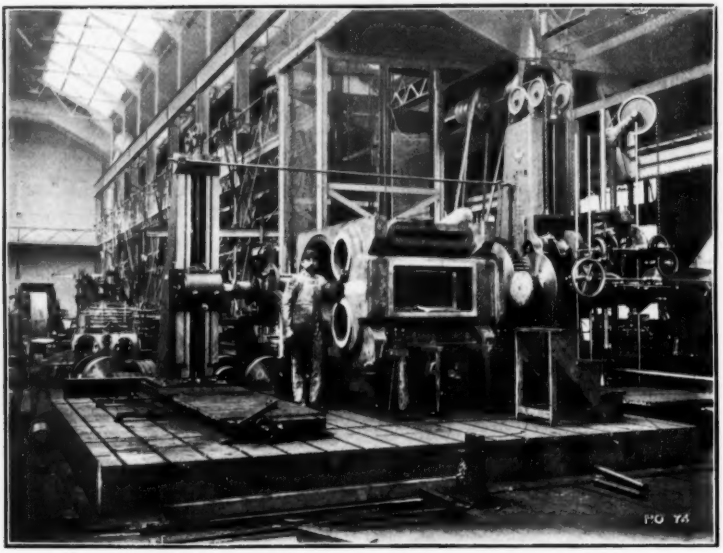
Mr. Welch's foundry inventions have reduced the cost of small machine moulding as much as the use of the turret has reduced the cost of machine-part finishing, or perhaps even more, as a very large part



HEAVY PLANERS, WESTINGHOUSE MACHINE COMPANY'S SHOPS.

of the hand moulder's time is occupied in operations which do not belong directly to mould-producing, while pneumatic moulding machines, in addition to the endless carrying-table chains, bring the Wilmerding mould-making costs to incredibly low figures.*

But turning to the Machine Company's shops, a totally different class of work is met. These shops which, when the additions now far advanced are completed, will have a floor area 1,500 ft. by 235 ft., with large gallery space in addition, are filled with tools of the latest and most improved description, and of a far heavier class than I was prepared to find in this establishment, which I had not visited since it was

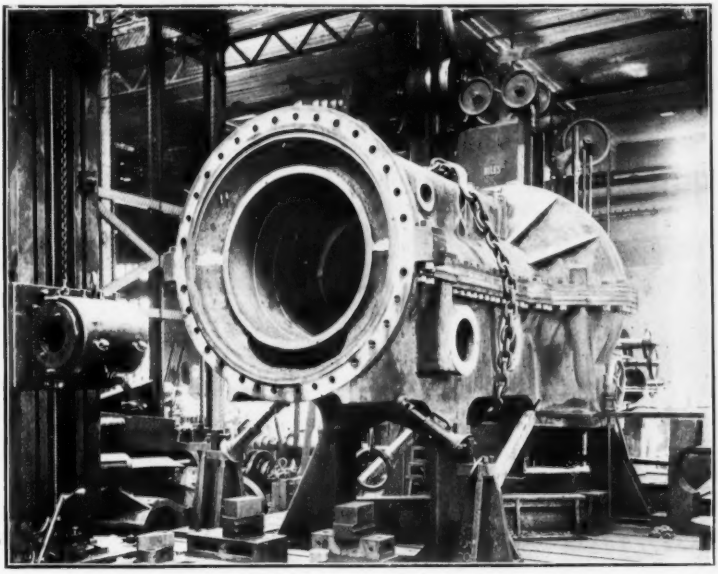


LARGE TRAVERSING-SPINDLE MACHINE, WESTINGHOUSE MACHINE COMPANY'S SHOPS.

wholly devoted to the production of single-acting steam engines in comparatively moderate sizes, say not much exceeding a cylinder diameter of 20 in. Instead of this comparatively narrow line of medium-sized productions, the work in hand includes some of the largest and heaviest Corliss steam engines for generating electricity, building the Parsons steam turbine in large sizes, and the triple-cylinder gas engine in units as large as 1,500 h. p. A 650-h. p. gas engine is a

* THE ENGINEERING MAGAZINE has now under engagement a series of articles on advanced foundry practice, by Mr. E. E. Hanna, which in text and illustrations will give a full and most valuable review of the best methods of the more progressive works.

standard production of the establishment. Considering merely the mechanical possibilities of adapting special tools to standard parts, one would expect to find in this shop great use made of the milling machine and of special machine tools, designed and built exclusively to suit the peculiarities of the constructions. The use of milling machines, however, appeared to have increased very little over that which prevailed in these works four or five years since. Two or three large machines of this character are employed in slabbing the peculiar form of connecting rods used in the single-acting steam engines and the

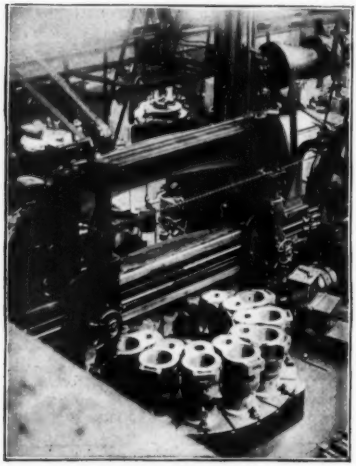


THE OUTER SHELL OR CASING OF A 1500-H. P. PARSONS STEAM TURBINE.

three-cylinder gas engines, but almost all of the flat surfaces are finished on planers of the ordinary type, although the vertical boring mill having a horizontal table is very much used for flat second cuts on parts which naturally have one flat cut made in the latter. The planers are in large sizes, and one just completed and running at the maker's shop, takes 10 ft. high x 14 ft. wide through the uprights and under the cross rail. This enormous tool is comparatively short, having, I think, a table travel of about 35 feet only. The table of one of the heavy boring mills shown in the illustration on the next page is filled with a circle of cylinders which have their upper ends faced (the lower ends

having been finished in the cylinder-boring machine), by a tool carried on a facing arm on the boring bar. The use of the boring mill in this manner, as a sort of rotary planer, is rapidly extending in American practice, and is highly economical in several directions, the finishing being effected much more rapidly than by the planer, or by the use of the boring-bar arm slide. The vertical boring mill is distinctively an American tool, and is vastly more convenient and rapid in action than the large-swing face-plate lathe, to which heavy European shops still cling so devotedly. America is, in fact, the only country which has made extensive use of the boring mill, especially in the way of surfacing a large number of comparatively small pieces at one setting.

At the time when I visited the shops the shell of a 1,500-h. p. steam turbine was in the boring lathe, and next in front of this huge structure was a three-throw crank-shaft for a 650-h. p. gas engine, also in the lathe. The construction of these heavy pieces has given rise to some of the most interesting and most characteristic special tools and special appliances in the shops, the merits of which are fully apparent only after consideration of the peculiar and exacting requirements to be met. In the case of an ordinary steam engine or internal combustion motor the part receiving the impulse of the steam or gases commonly takes the form of a piston, sliding in close contact with the walls of a cylinder in which it travels back and forth. In the case of water wheels and the steam turbine, vanes are substituted for pistons, these vanes having a radial movement instead of the axial sliding movement of the piston in the cylinder. The vane action is almost precisely the same in form and operation as that of the curved paper wings of the toy known as a "pin wheel," in which the wind or a current of air produced by moving the toy rapidly, causes the paper spiral wheel to turn. In the case of



HEAVY BORING MILLS, WESTINGHOUSE MACHINE COMPANY'S SHOPS.

The horizontal table of the large mill is filled with cylinders, arranged in a circle. The lower ends of the cylinders have been faced in the cylinder-boring machine; the upper ends are very rapidly and cheaply finished in the boring mill, as shown.

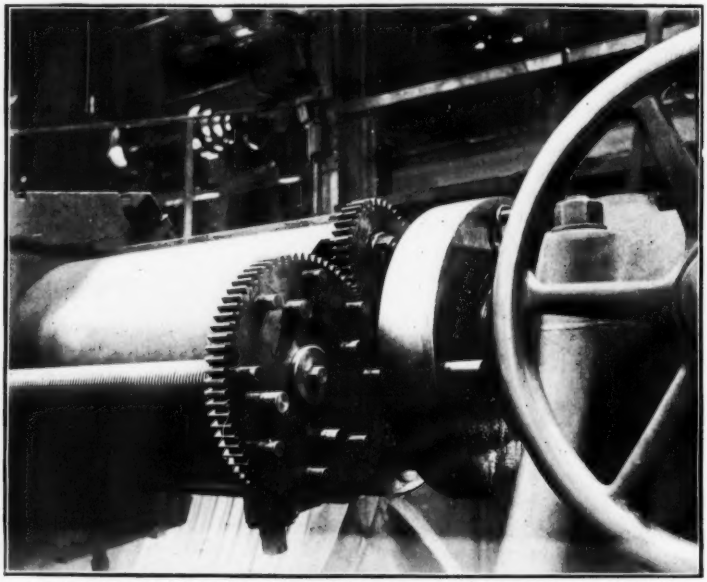
BORING BAR IN PLACE IN LOWER PART OF THE TURBINE SHELL, WITH THE CAP REMOVED.

the water turbine, the vanes have considerable clearance in the water-confining and directing case which surrounds them. In the steam turbine, however, this surrounding-case clearance is lowered to the smallest practicable limit, and where the steam turbine is produced in such large units as 2,500 h. p., as it is in these shops, there is a wide field for the application of the tool-maker's art in the construction of the enormous boring bar which finishes the inside of the turbine casing, and in making the thousands of bronze vanes and fixing them to the massive shaft or "spindle" which constitutes the revolving part of a steam turbine.

I regret to say that only meagre details can be given because of pending patents. The illustration on page 733 shows the two halves of the outer casing planed and bolted together, at the large traversing-spindle machine, for rough boring. The interior surface of this casing, when finished, presents a most elaborate assemblage of depressions and elevations, which must be produced with all possible accuracy, and form an extremely difficult construction problem in such a large size. To meet the requirements of this inside finishing a special boring bar was constructed, the rough forging for which weighed 16,000 lbs. This bar has a 6-in. hole chucked through it from end to end, and is provided with a number of sliding heads and collars, and also has a hexagon section of six plane faces, to which "wings," or angle plates carrying wedge-actuated banks of grooving tools, are secured. The final accurate finishing of the bore of this enormous

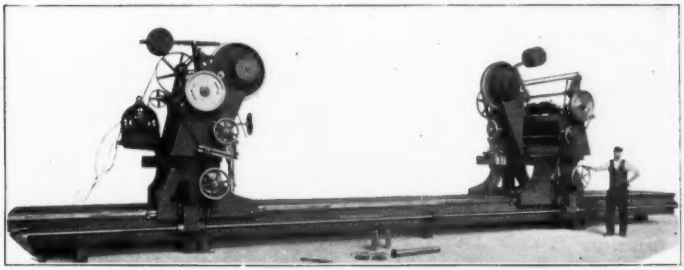
casing was done with the aid of this bar in the lathe, the process being first to adjust tools for cutting the grooves, in the lower half of the casing, so that every cut could be exactly measured, and then to withdraw the tools seated in the boring bar "wings," to bolt the cap in place, and finish the grooves by manipulating the grooving-tool wedges from the outer end of the bar.

There is only one special tool of home construction in the Westinghouse Machine Company's plant, so far as I saw, and that is a small and novel balancing machine in which the work is not revolved to test its balance. With this exception, all the machine tools in use are the



ACTUATING PARTS OF THE LARGE BORING BAR USED IN FINISHING THE PARSONS TURBINE SHELL.

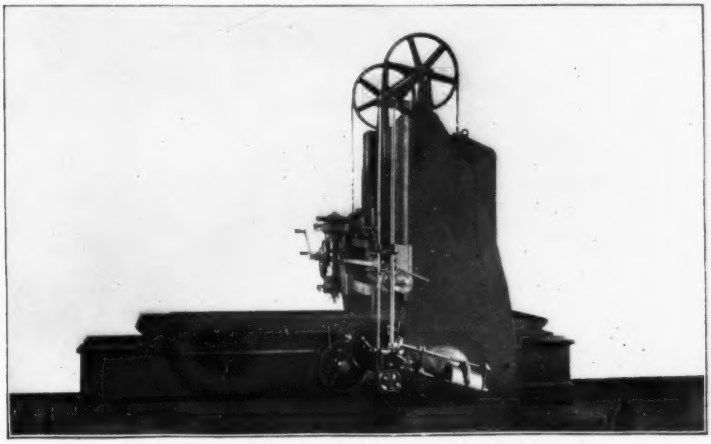
regular productions of well-known makers. The small parts are finished on the Hartness flat-turret lathe and on the Gisholt turret lathe, a considerable number of these machines being employed. Great use is made of the traversing-spindle milling, drilling, and boring machines in different sizes. For finishing crank-shafts, the ordinary methods are followed, the only unusual tool being a large vertical planer, or slotter with a worm-driven ram, which carries two slotting tools for slotting up both sides of the crank-wrist cut in a crank-forging blank at once. When these side cuts are made the side-cleared "throat



DOUBLE SLOTTING MACHINE FOR LOCOMOTIVE SIDE FRAMES.
Stroke adjustable up to 22 in. Bed 42-ft. long. Travel of heads on bed to suit frames 32-ft. long. Driven by electric motors. Wm. Sellers & Co., Inc.

block" is removed by drilling across in a single-spindle vertical driller, and the shaft is then finished in the lathe, in the ordinary manner.

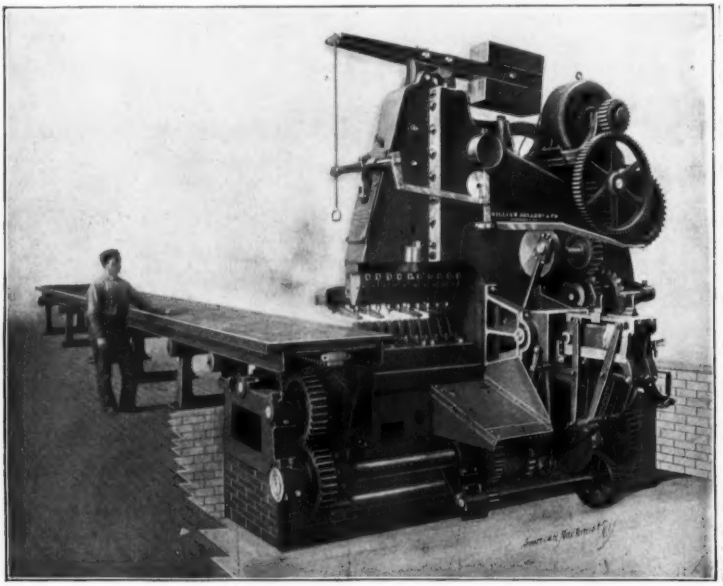
A very accurate system of obtaining and recording all of the essential sizes of every important piece made in these shops has been devised and installed by Mr. Thomas. This system involves new applications of the micrometer to large-size measurements, and such specially prepared book forms of record as enable the exact duplication of any piece ever sent out which is at all likely to require replacing.



TRAVERSING MACHINE FOR SPECIAL WORK ON ENGINE BEDS.
48-in x 48-in. x 12 ft. Built by Pratt and Whitney for the Straight Line Engine Company, from designs of John E. Sweet. The peculiar feature of the machine is a perfectly guided cross rail, counterbalanced and with power up-and-down feed. It thus becomes a boring and drilling machine as well as traversing in four directions. The joints of steam-chest covers are finished perfectly, requiring no scraping, grinding, paint, nor packing.

The Westinghouse steam engines, of the single-acting self-contained type, both simple and compound, are repetition productions of large dimensions, just as the air brake is a repetition production of much smaller dimensions. The gas engines are made in all sizes up to 1,500 h. p., and the tool-making employed in producing these engines is of great interest, as it exhibits the most advanced tool-making practice within my knowledge in piston and cylinder-motor construction.

There is, however, apparently little in the practice of the Westinghouse Machine Company to support the contention enunciated in the opening paper of this series, to the effect that the advanced machine shop will not make a very large use of thoroughly skilled mechanics in the creation of its commercial product. While the tool-maker, in his narrower field of deviser and constructor of improved means and ap-

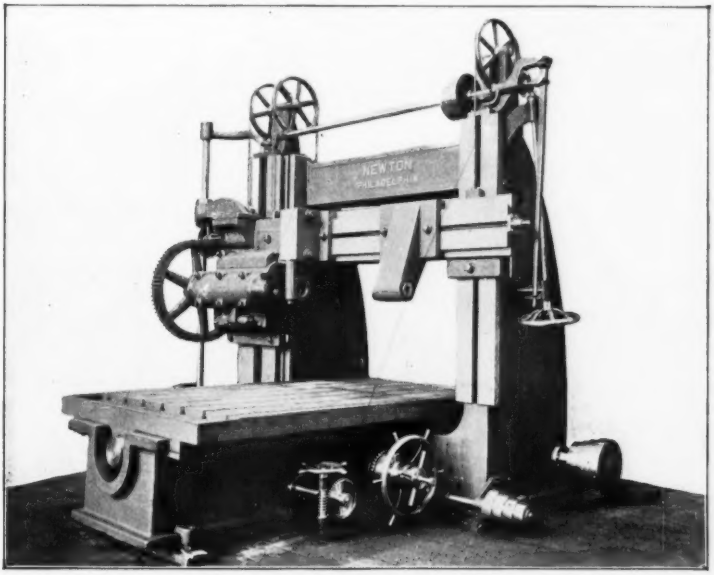


MULTIPLE PUNCHING MACHINE WITH AUTOMATIC SPACING TABLE.

The spacing table, 42-in. wide, is carried in roller bearings and will space automatically up to 8 in. by increments of 1-16-in. Wm. Sellers & Co., Inc.

pliances for removing metal from parts which require finishing, as well as in that wider field which embraces methods and sequences without touching on machine-tool details, is everywhere most prominently visible, by far the larger proportion of the workmen are skilled gen-

eral machinists, not 10 per cent. of the whole number falling into the class of specialized laborers. In the air-brake shops, however, as already stated, the conditions are entirely different. The broad differentiation between the two establishments is this: the machine works

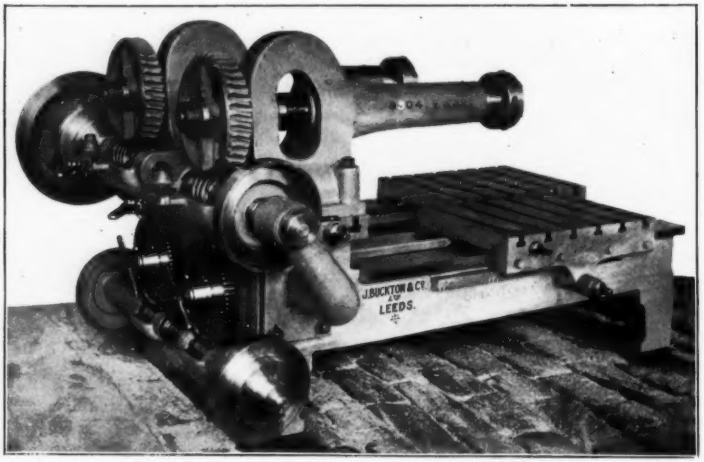


ONE OF THE LARGEST MILLING MACHINES MADE IN THE UNITED STATES.
Admits work 6 ft. wide by 5 ft. high, to mill 10 ft. long. Weighs about 72,000 lbs. Newton Machine Tool Works.

are operated wholly with skilled labor and without special tools, while the other shop is operated almost entirely with "specialized laborers," and especially constructed and adapted machine tools. In both shops the work produced is of the highest excellence, and in both shops the hour cost of production is very low.

Why then should there be such a radical difference between the two in the machine-tool equipment and the class of labor employed?

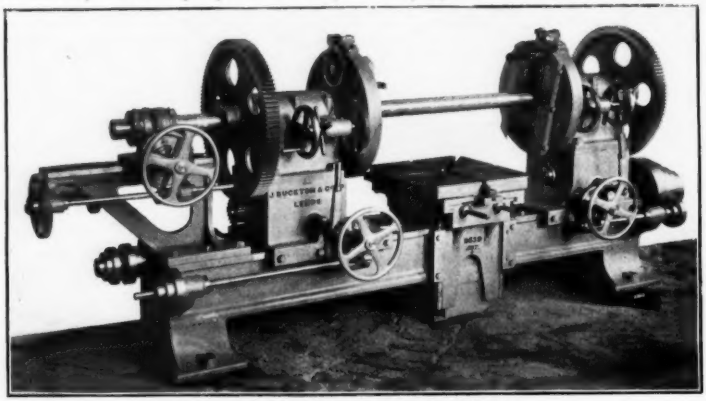
Manifestly there is a size limit—perhaps it would be correct to say a diameter limit—up to which the specialized laborer and the special tool can readily go, and beyond which the general machine-shop equipment and the skilled general machinist must still be employed. With sizes under this limit the whole round of manufacture can fall into routine procedure, without the exercise of discretion on the part of the operative. Beyond this limited maximum diameter various



DUPLEX BORING MACHINE FOR LOCOMOTIVE CYLINDERS.
Adapted for inside cylinders of locomotives, and for other double-cylinder engines. Spindles adjustable and independent, tables operated independently or together. The manner of supporting the heads renders any outboard bearing unnecessary. J. Buckton & Co., Leeds.

exigencies of construction begin to demand the exercise of independent and discretionary powers by the workman.

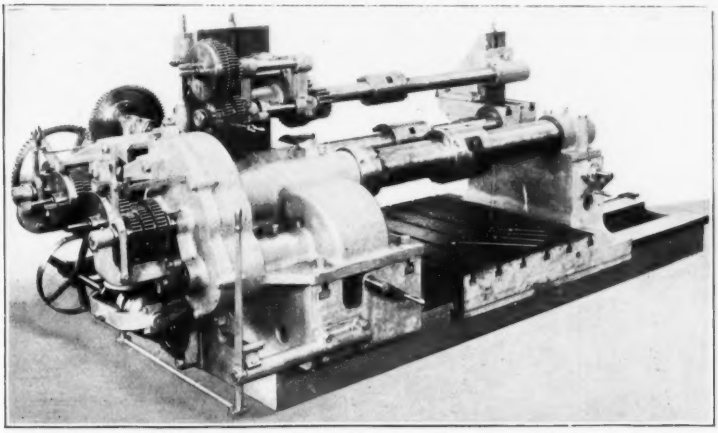
Again, up to a certain diameter limit special tools of not unwieldly or unduly flexible proportions may be employed, while above this limit



DUPLEX FACING AND BORING MACHINE.
For facing two ends and boring cylinders simultaneously. Transverse, vertical, and rotary movements to table, enabling four flanges to be finished at one setting. Boring bar can be withdrawn through headstock. J. Buckton & Co., Leeds.

the first cost, the floor-room, and the up-keep of the highly specialized machine tool, together with the limited demand which is inseparable from larger constructions, overbalance all possible savings of labor-hour cost to be gained by the use of large and highly elaborated special tools. What this ultimate diameter limit is, is as yet unknown. The air-brake work considerably exceeds 12 in. in diameter, and it seems possible that work up to 16 or 18 in. diameter might be automatically produced in the machine shop if the demand for the product could be made large enough to justify the enormous expense of equipment.

A review of other American shops where heavy work is done sug-



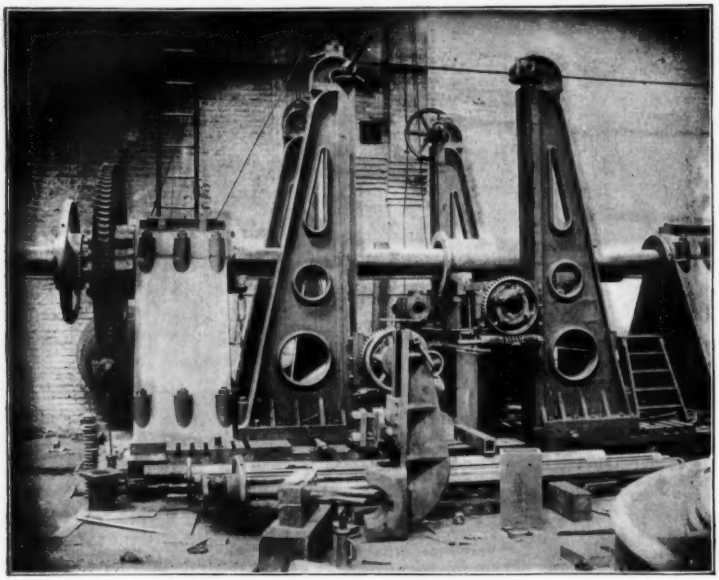
TRIPLE BORING MACHINE FOR CYLINDERS OF VAUCLAIN COMPOUND LOCOMOTIVES. BALDWIN LOCOMOTIVE WORKS.

The work is carried upon a table, and the cutter heads travel along their bars, which are proportioned to suit the diameter of the various cylinders. Two bars are adjustable, so as to cover almost every position in which the three cylinders can be arranged. Wm. Sellers & Co., Inc.

gests that instances exceeding these upper limits are exceptional. At the Pond Shops, Plainfield, N. J., the only tool which I remember as possibly to be classed in the "special" list, is a large face milling machine, or "rotary planer," spindle horizontal, and machines of this form, though not very common, are perfectly well known.

At the Baldwin Locomotive Works, Philadelphia, where the most advanced types of heavy tools have been always in favor, there is a tool of this rotary planer type, by Sellers, used in finishing driving boxes. The Baldwin shops also have some vertical-spindle tools in the general form of upright drillers, which are used to grind the cylinder heads and flanges together. Another special tool at the Baldwin

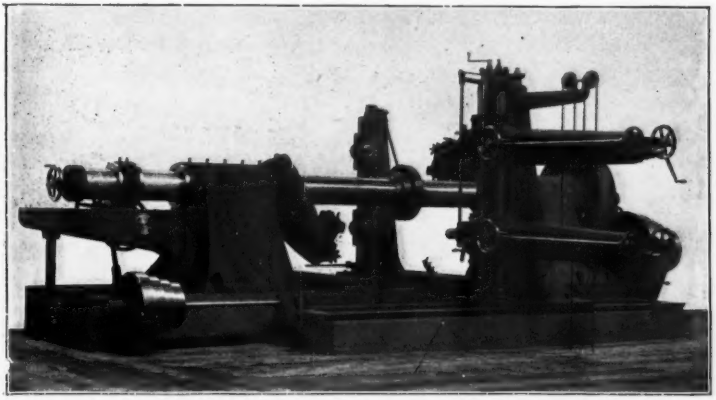
shops is Vauclain's taper-bolt body milling machine; this machine has a number of vertical spindles, each carrying a long hollow mill at its lower end, the hollow mill being made with one flat cutter the length of the bolt body to be produced, and two back-rest surfaces, and the work being wholly submerged in a tank of oil while in process of finishing. The standard taper of locomotive bolts is, I think, ⅛ in. to the foot, and but few taper-body locomotive bolts exceed 10 ins. of body length. This submerged broad-cut milling tool is extremely rapid in action, and produces work regarded as wholly satisfactory.



CORLISS-CYLINDER-BORING MACHINE.
Used and built by Fraser and Chalmers.

There are some very early types of milling machines, "special" at the time they were made, in the Baldwin shops. The Baldwin cylinder-boring machines are worm and worm-gear driven, and are compact, simple, convenient, and effective tools. For boring the Vauclain compound-locomotive cylinders, a special boring machine is used, having three horizontal parallel spindles, built by Sellers. The Baldwin also has one or more special frame-planing machines, by Sellers, which are extremely rapid in action.

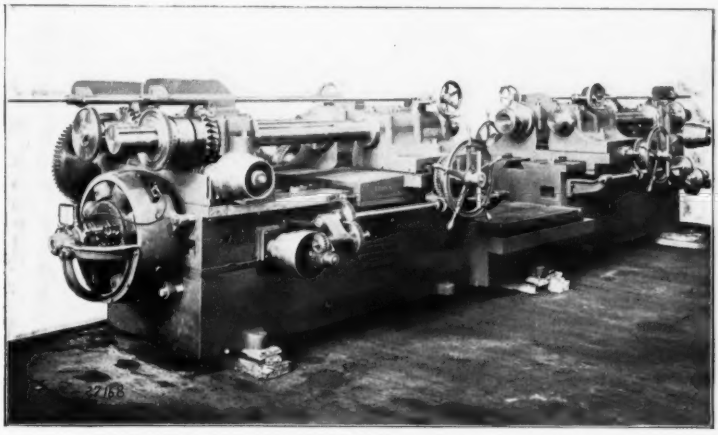
At the Allis shops, Milwaukee, there has been developed a Corliss



CORLISS-CYLINDER-BORING MACHINE WITH TWO CROSS SPINDLES AND FACING HEADS.

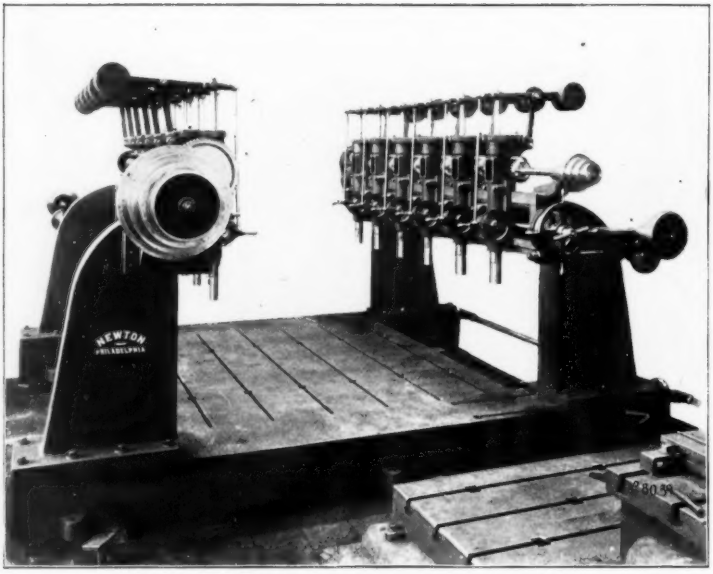
Takes cylinders up to 42 in. diameter and 10 ft. long. The valve seats, at right angles to the axis of the cylinder, can be bored while the cylinder boring is in progress, and with absolute precision. Niles Tool Works.

cylinder-boring machine having cross boring spindles at right angles to the cylinder-boring bar, so that the valve seats, at right angles to the cylinder bore, can be bored while the cylinder boring is in progress. The first tool of this description, a small affair, was, I think, built at the



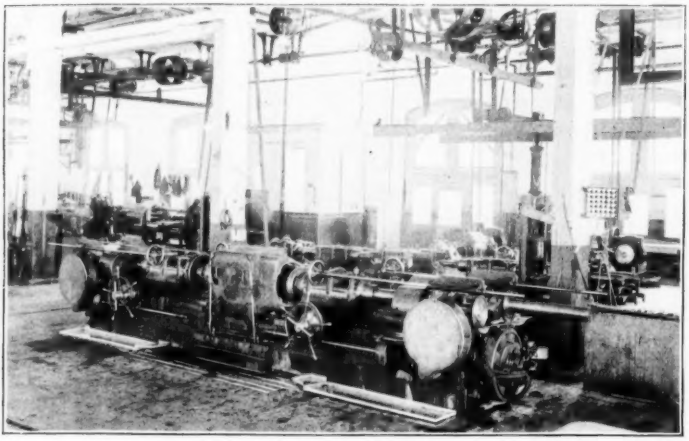
4-SPINDLE BORING MACHINE FOR STREET-RAILWAY MOTOR FRAMES

Used by the General Electric Company, Schenectady, N. Y. The first machine had an electric motor clamped in position. The reconstructed machine, shown above, has a direct-coupled electric drive. Newton Machine Tool Works



12-SPINDLE DRILLING MACHINE FOR REPETITIVE WORK.

The machine is used for drilling the truck frames of a standard pattern of railway car. Newton Machine Tool Works.



BORING MILL FOR ELECTRIC RAILWAY MOTORS.

In the General Electric Company's Shops. Driven by 10-h.p. 250-volt electric motor.

Allis shops, and the design was, I believe, by Reynolds. The Watts-Campbell shops, Newark, N. J., have a fine Corliss cylinder-boring machine, with two cross spindles, designed and built on the premises. Although the Niles shops and Bement drive the bars of their cylinder-boring machines with worm gearing, the large bronze worm gear which was first used to drive the cylinder-boring bar of the Watts-Campbell Corliss cylinder-finishing machine wore out so rapidly that a spur-gear drive was substituted. The Watts-Campbell shops also make use of movable-bracket carried slabbing mills, vertical spindles, applied in a very ingenious manner to Corliss cylinder-finishing. The Waterman Company, now out of business, built one or more Corliss cylinder-boring machines after the Reynolds plans for the Allis Company, and the Niles Tool Works built a very large machine, having two cross-spindles in traversing housings to Reynolds' specification for the Allis Company, and made it a regular product. The De La Vergne Company, Port Morris, N. Y., has one of these large Niles Corliss cylinder-boring machines with two cross spindles, of the type shown in the engraving on page 743.

The Fraser & Chalmers Company, Chicago, also have a very large Corliss cylinder-boring machine of their own construction, which has cross spindles for boring the valve seats of Corliss cylinders simultaneously with the boring of the cylinder itself.

The traversing-spindle milling, drilling, and boring machine is a universal tool which has come into general use in heavy shops in the last twenty or twenty-five years. Prototypes of this tool in small sizes are still in use. One of these early examples is to be found in the shops of the Providence Steam-Engine Company, Providence, R. I. The date of building of this tool, which has a vertically adjustable horizontal spindle on a stationary vertical bracket, and is served by a travelling table to which the work is secured, has passed into oblivion, but the tool is thought to be over half-a-century old; it is still in excellent condition, and is in daily use.

I think the first large traversing-spindle drilling, boring, and milling machines were of British construction, but this type of tool in heavy sizes was produced as much as twenty-five years ago by American makers, and is now marvelously convenient and rapid in adjustment.

The General Electric Company, Schenectady, use a special four-spindle tool, by Newton, for finishing the frames of street-car electric motors, which is very effective, and is also a very beautiful example of special-tool design. The General Electric Company also has in use

independently-movable electrically-driven slotting slide pillars, which can be placed in any desired position on a very large T-slotted sole plate. The method of using this combination is to bolt the large work, requiring finishing in limited areas, to the sole plate, and then shift the slotting slide pillars to suit the work to be done, and bolt them in operative position, thus making a universal tool, applicable to finishing a great variety of surfaces otherwise extremely difficult to bring under the action of power-driven cutters. The same general idea runs through both the traversing-spindle machines and the independent slotting pillar machines. There is, in both cases, a large T-slotted sole plate to which the work is secured, and the cutting tools, carried on a movable pillar provided with means for actuating the cutting tools, are then brought into the needful position to effect the desired operations, thus, broadly speaking, bringing the tools to the work they are to finish, instead of, as with the common forms of lathe, boring machine, slotter and driller, and planing machine, bringing the work to the tools. This practice is well illustrated by the example shown in the engraving on page 730.

In the Straight Line Engine shops, at Syracuse, N. Y., a special traversing machine, built by the Pratt & Whitney Company from Prof. Sweet's own designs, is used to finish engine beds at one setting. It is possible by its use to end mill five sides of a piece and drill or bore holes in any one of the sides at one setting, and the joints of the steam-chest covers are so perfectly finished as to require no scraping, grinding, paint nor packing of any kind. It is, in fact, a very complete example of the adaptation of the machine tool to repetitive production of pieces of large size, with a minimum of skilled attendance or individual discretion on the part of the attendant.

All of these tools specified, which are the principal additions made in the most modern heavy shop to the earlier lathe, planer, and slotter outfit, are general tools, having very wide ranges of application, and hence do not fall in the "special" class.

As previously mentioned, the "diameter limit" sets the bounds and marks the scope of special-tool making, so far as the most advanced practice of to-day is concerned.

THE DEVELOPMENT OF WIRELESS TELEGRAPHY.

By Patrick B. Delany.

A LITTLE more than three years ago, a young student, twenty-two years of age, came from his books at Bologna University, Italy,* to London, to consult Sir William Preece, at that time engineer-in-chief of the British telegraphs. Young Marconi had an idea. He had studied under Prof. Righi and was familiar with the wonderful discoveries and experiments of Prof. Hertz of Bonn. He had also made some experiments on his own account, but had he remained at home his distance record for wave telegraphy might not have beaten that of the half score of others who have since been trying to establish for themselves a record of fifty yards or so before Marconi was heard of. That scientists of high renown should be content with the comparison of fifty yards against fifty miles, or more, covered by the school boy, is the greatest possible compliment to the lad.

Marconi made no mistake when he wandered into Mr. Preece's office. He may have heard that no inventor with a meritorious idea or machine ever met with a discouraging reception from that far-seeing, scientific, and practical official, himself at the very time carrying on experiments for wireless communication across the Bristol waters on the induction plan. Preece's work in this and all other methods of telegraphy had been of distinguishing character for more than forty years, he having started his career in Faraday's laboratory.

From Marconi's first visit to Mr. Preece's department his invention grew, each succeeding trial stretching the distance, until England had talked with France. Little or nothing has been said or written about the splendid help given to the new plan by the engineering branch of the British post office, but it may be safely assumed that to the practical experience and great skill of the head and staff of that department belongs much of the credit for the rapid development of Marconi's system, and, curiously enough, during the first year of its operation Mr. Preece had to devote much of his time to defence of the scheme and of his countenance of it.

Like most great inventions or improvements in the arts and sciences, wireless telegraphy is the outcome of the labor, not of one man, but of several. Let us see to what extent the way had been marked out for Marconi. He studied Hertz, and Hertz studied Max-

* Guglielmo Marconi was born near Bologna, Italy, Apr. 25, 1874, of Italian-Irish parentage.

well, who had Michael Faraday's experiments before him showing some sort of relationship between electro-magnetic waves and light. Hertz could not have overlooked Prof. Henry's discovery forty years before, of the effect of an electric spark upon a distant needle, the spark being given off in the attic of his house and the needle being two hundred feet away. He noted also the effect of a flash of lightning several miles distant. Still more important was his elucidation, in 1876, of the theory which Hertz so brilliantly demonstrated in 1889—that electricity of great pressure, tension, or electro-motive force (oscillatory) skimmed along the surface of the wire without penetrating it, and that only electricity of comparatively low pressure entered the mass of metal. In fact, Henry demonstrated this discovery himself most conclusively in his well known gun-barrel experiment. He was at the time advising a friend how to make lightning rods, and proved that a flash of lightning would travel along an ordinary gas pipe as well as over a solid copper rod of the same diameter.

James Clerk Maxwell, in 1873, after nearly ten years' investigation, published his famous mathematical equations establishing the law of identity of light and electro-magnetic propagation through the ether. Prof. Fitzgerald, of Dublin, had already affirmed his belief in the theory. Hertz proved this by actual measurement of the waves. This is the work that made him famous—and deservedly so, for the way he went about it, the masterly treatment of causes and effects, gained for him the unstinted admiration of the scientific world.

By discharging a Leyden jar, or Ruhmkorff coil, through a short piece of wire circled so that its ends came very close together, the spark jumping the gap was reproduced in another metallic ring suspended by a string thirty feet away. The spark jumping the gap in the second ring proved at once the transmission of electro-magnetic waves through space, or, as there is no space, through the ether. The second spark at a distance also enabled him to measure the waves and fix their rate, proving that they might be a fraction of an inch or 1,000 miles in length, and determining their periodicity to be about one hundred millionth of a second, waves of 2.8 meters in length having the velocity of light, or 186,000 miles a second. He demonstrated that the waves could be reflected, deflected, and screened, and determined their nodal point and outline, all within the walls of his thirty-foot laboratory.

Prof. Lodge and others had experimentd with wave transmission before Marconi came on the scene. The waves had been sent through walls and other obstacles, but the idea of using them for long-distance

telegraphy, if thought of at all, was not seriously considered. Prof. Lodge says that nothing but "stupidity" prevented it. It was known that the Hertz detector would not work more than fifteen or twenty yards distance, however, and would never do for a receiver of wave signals transmitted from any considerable distance.

Prof. Hughes, the inventor of the microphone, had discovered that a high-tension spark affected certain forms of his instrument at a distance, and claims to have been quietly planning a wireless telegraph for years before Marconi was heard of. Onesti, an Italian professor, had experimented with copper filings as a variable conductor, but it remained for Prof. Branly, of the Catholic University of Paris, to produce the "coherer," a working receiver for electro-magnetic waves transmitted through the ether. During a series of experiments conducted early in 1891 Branly showed the susceptibility of various metallic powders or filings to the Hertz waves, and an enormous increase in their conductivity when brought within the influence of such waves. Furthermore, he showed that it was necessary only to shake the filings up to restore them to their normal state of low conductivity. The electric wave packed them together, or made them cohere, while a shaking up caused them to decohere. In this simple little device, not larger than two inches of lead pencil, coupled with the Hertz oscillator, Marconi saw his wireless telegraph, and proved the truth of Prof. Lodge's rueful remark that "nothing but stupidity" had delayed the wonderful achievement. Still, it should be remembered that the "oscillator" (transmitter) of Hertz and the "coherer" (receiver) of Branly had been tried before Marconi took them in hand; but, while certain manifestations of their action had been obtained, nothing in the nature of telegraphy was done, and about fifty yards was the limit of the effects.

It should be pointed out here, however, that Prof. Dolbear, of Tufts College, Massachusetts, exhibited at the electrical exhibition, Philadelphia, 1884, an arrangement for wireless signalling which had operated over similar distances. This was several years before Hertz or Branly, but his method was not the same. He used an induction coil as a generator and a telephone as a receiver. By connecting one terminal of the secondary of the induction coil to earth, and the other to one side of a condenser the other terminal of which had points for "discharging into the air," a telephone transmitter or Morse key, operated in the primary circuit of the induction coil with a powerful battery, produced audible sounds in a telephone receiver one hundred feet away. One terminal of the telephone was connected to earth, the

other through a battery to condensers arranged as at the transmitting end. Dolbear's idea was apparently not the transmission of electromagnetic waves through the ether, but the electrification of the two "ground" wires and the changing their potential from positive to negative whenever a signal was sent. Regardless of the possible limitations of this method for practical use, it was an original conception of the highest order of genius, and in one feature furnished in advance the main requisite for long-distance signalling—*the vertical wire*, for, without this, it would even now be impossible to telegraph half a mile with the Marconi system.

As Marconi himself made numerous unsuccessful attempts before adopting the perpendicular conductor for the emission of the waves, it is but fair to infer that he had not known of what Dolbear had done. Indeed, according to an account by Prof. Slaby, of Charlottenburg, he and others had been assisting Marconi in trying to establish communication between two points in England, and had spent nearly the whole day without success, when Marconi picked up his receiving apparatus from where they had been vainly striving at the top of a high bluff, and carried them down to the water level, leaving the wire at the top and connecting the apparatus to its lower end. Immediately the signals began to arrive, and perfect working was established with the station some miles away. Marconi was no more likely to have known of Dolbear's kite wire than others, none of whom had tried it.

Even with these three fundamental features, the oscillator, coherer, and vertical wire, there were still serious difficulties to be overcome. The coherer as a "detector" was by no means a telegraph instrument. Marconi, by shunting it with a local circuit in which were connected a local battery, a recorder, and a "tapper" to shake the coherer filings apart after each signal impulse, made the coherer perform the work of the ordinary telegraph relay in general use. These arrangements may be said to be details, accomplished by the use of accessories of ordinary experimentation, but they are of prime importance nevertheless. Marconi's combination of features which had been used only to prove a theory with apparatus that had long been in commercial use shows that he started out with a comprehensive grasp of the importance of his undertaking and a determination not to be balked by the failures of others, or by their belittling criticisms, which were plentiful at the beginning of his work. As Sir William Preece put it in defending him, "they all knew the egg, but Marconi had shown them how to make it stand on end."

The arrangement of apparatus comprised in the Marconi system

has been shown and described so generally it is hardly necessary to use diagrams in this article. It consists, briefly, of an induction coil, in the primary circuit of which is a Morse key and about fifty cells of dry battery, One terminal of the secondary coil is connected to earth, the other terminal to a vertical wire carried upwards as far as practicable—say, one hundred and fifty feet.

The terminals of the secondary coil, from which the earth and vertical wires lead, are also connected each to a brass rod having a round knob at the end; these knobs form the oscillator.

At the receiving station there is also a vertical wire. It is connected to one terminal of the coherer, the other terminal of which is, preferably, connected to earth. The coherer is a glass tube, two inches long and of goose-quill diameter. The center of the tube, for about one-eighth of an inch, is filled with metal filings; almost any kind will answer. The terminal wires are led into contact with these filings, which form the connecting link between them. The air is (preferably) exhausted from the glass tube. At the points where the vertical wire and the earth wire enter the coherer tube the wires of the local circuit are joined, and, as already stated, the recorder and tapper with a cell or two of dry battery are included in this local circuit. This is the operation: When the key of the sending station is pressed down, the primary circuit is charged directly, and the secondary circuit inductively. The automatic or mechanical interrupter of the primary causes interruptions in the secondary at the same time. These induced currents jump across the gap between the two brass knobs, charging the vertical wire with oscillatory electricity of great electro-motive force. This electricity spreads out from the wire like the waves caused by the splash of a stone in smooth water. These electric waves are vibrated through the ether at the rate of about two million a second and with the velocity of light.

They compass the vertical wire at the receiving station, pass through the filings in the glass tube to earth, and in doing so cause these filings to lie closer together and cohere. This makes them a good conductor for the local circuit in which the recorder and tapper are placed, and permits the cell or two of battery to work these instruments. When the lever or the tapper comes down it jars the filings apart, or decoheres them, making them a bad conductor again, practically breaking the circuit of the recorder and tapper, which in itself is nothing but an ordinary telegraph sounder. The coherer is now again in a receptive disposition for the next signal. Various modifications of this arrangement have been suggested and patented by

Marconi and others, such as using an induction coil at the receiving station also, and placing the coherer in the secondary circuit, with or without condensers, so that the filings will be affected by the induced current produced by the passage of the original current through the primary coil, etc.; but these are not of importance here.

Certain drawbacks relating to transmission and reception of actual Morse dots and dashes limit the rate of working to about twelve words per minute, or about half the speed of a good wire circuit. So far as I know, the main trouble lies in the slow rate at which the primary circuit of the induction coil at the transmitting station is made and broken by the automatic interrupter, said to be eight or nine times per second. Now, as it is possible for a Morse operator to work his sending key sixteen times or more per second, he must, with the present rate of vibration, work the key at a rate considerably less than eight per second, as otherwise the waves would not be sufficiently continuous to deliver the dots and dashes to the receiver. When the key is pressed down for a dot it must not strike in between the makes and breaks of the vibrator, and when held down for a dash it must be for sufficient time to insure a full sized one. Thus all the characters, dots and dashes, are made up of fine dots. The ink recorder must be so adjusted that its marking point will not respond to the fine dots, but only to the characters formed by the sending key, which are made up of short and long showers of short pulsations. The tapper, however, to be effective in shaking the coherer, must be adjusted so as to respond to every short impulse, otherwise the filings would not be ready for the next succeeding wave. It would seem from this that to the limitation of the speed of the tapper lever may be attributed the imposed low rate of automatic interruption of the primary circuit at the transmitting station, and hence of the speed of transmission. The tapper might be made to respond more quickly by increasing the local battery and the tension on its pull-back spring, but strong local currents must not be sent through the coherer, as they would cause more self-induction in that circuit, requiring more counteraction by condenser discharge, etc. An increase in the rate of automatic interruption of the primary circuit would not only permit of greater speed of transmission, but probably would increase the distance of communication, as the more quickly the sparks follow each other in bridging the gap of the oscillator, the greater the power of propagation through space. It is hardly probable that the coherer in its present make-up will abide as the receiver for wireless telegraphy. Some device of more

positive action will take its place. One has already been proposed by Prof. Fessenden, of Allegheny.

In view of the previous creation of all the separate parts of Marconi's system (the tapper included), even those most generously disposed towards him find it difficult to form a basis for as much credit as they think he deserves for the results obtained. But, as already stated, it should be remembered that all these separate parts had been in existence for several years before and were well known to veterans in the field of electrical investigation, and yet nothing of any practical value in the way of space telegraphy had been accomplished. Leading scientists had, it is true, been talking about it for half a century by conduction and induction, and by Hertz-waves since their discovery, but none of them seemed to have faith enough in the soundness of the demonstrated theory, or ability to tackle successfully the practical side of it with that pluck and perseverance necessary to carry it through. Surely the inducement was ample for the highest order of genius. The earth-conduction plan and the induction plan had resulted in reaching out four or five miles, using parallel wires of a mileage twice the distance spanned. To communicate fifty miles without parallel or other wires would have crowned the loftiest ambition of the most distinguished. Marconi's sudden bound into fame is the proof. He joined up the elements of success in a masterly way and jostled the savants out of his road.

There is one peculiar circumstance in connection with Marconi's work which other experimenters are just beginning to notice. It is, that, notwithstanding the fact that hundreds of them connected with war, navy, and the telegraph departments in their respective countries, as well as scores of others working in their individual capacities, all have full specifications of Marconi's patents before them, as well as published particulars of his arrangements for working, in no single instance have results been obtained approximating those secured by Marconi himself. The wide discrepancy can hardly be attributable to superior expertness in adjusting apparatus, or arrangement of details. There must be something more, and, as the coherer is the only part of the system susceptible of unlimited change without outward manifestation, it may be that Marconi is in no hurry to disclose *all* that he knows of the subject, knowing, as he does, that all the world is now his competitor.

While electro-magnetic waves have been sent three hundred feet into a coal mine, made to penetrate stone walls, and warp over hills, they experience obstruction and distortion in all these things.

The farther away from the earth, the better they go, some say, because the high strata are better conductors. Maybe it is owing to removal from obstruction, and it is not improbable that the electrostatic capacity of the earth itself may play a part. Experience shows one hundred and fifty feet of vertical wire to be necessary for sea distances of fifty miles. From balloons a mile or so up, and with powerful waves, it might be possible to telegraph across the Atlantic. The sea is undoubtedly the field, so to speak, for the new system. Communication between ships, warning them away from dangerous coasts, covering areas with appeals for help in distress, directing and controlling torpedo boats, as designed by Mr. Tesla, controlling balloons—in fact, almost any work possible by a wire, and much that is not may be done by the wireless system, provided it is kept away from the earth's topography, and the things covering it. One of the shortcomings yet to be overcome—and it is not easy—is the "town crier" character of the new transmission. It can, to some extent, be shut off from one section and projected over another, like the searchlight or the sounds from a megaphone; but the outer edge of a long sector covers many miles. Synchronism, resonance, etc., have been proposed, but up to this time the system in its simplest application would not admit of any added complication. Until some plan of selection is found, the scope will be comparatively narrow.

Messages may be received by any number of coherers. And there is no means of discovering that the etherial line is being tapped; or, an oscillator turned on anywhere in the vicinity of an operating plant will thwart its usefulness. It may be that telegraphy will not be the most important use for electric waves. A few years may develop applications not now thought of. No wider way has ever been opened for scientific observation of the relation of electricity to physical existence.

The first flash of lightning to find within range of its magnetic wave a few particles of metallic dust in the bosom of some caverned rock or mountain peak put into operation the fundamental principles of wireless telegraphy. Under the influence of the lightning bolt, the metallic particles were compacted together, making them a better conductor. The thunder's rumble immediately following shook them apart, making them a poor conductor. The clouds constituted the oscillator, the flash the transmitting wave, the metallic dust the coherer and the thunder jar the tapper. It would, indeed, seem that in Nature's laboratory all things are in operation, and that man needs but draw the curtain to disclose them.

EDITORIAL COMMENT

Reviewers of the Spanish-American war have again and again pointed out that Spain had all the advantages of equipment which modern invention affords. She had the best ships and armament money could buy. Yet southern mechanical ineptitude produced an apparent disparity which was absolutely pitiful, as it was shown in the naval battles of the summer of 1898.

The war in Africa, on the other hand, is a sombre display of the effect of military mechanics when the opposing sides are more nearly equal in skill in handling war machinery. The Boers are not a mechanical people, but the "vigour of the northern brain" is there, and race characteristics show themselves in ability to handle the engines and appliances of battle, though they did not build them.

* * *

Col. Prout sides with some other railway experts, and with other authorities familiar with Africa's conditions if not with transportation matters, in his doubts of the economic advantages of the Cape-to-Cairo line.

But the best of these critics will be readiest to admit that undertakings so broad in character as this have repeatedly triumphed over all doubt and confuted the most careful calculators of their future. So it was with the Suez Canal; so, to take a case more nearly in point, has it proved with the transcontinental lines of America, against which were brought the very same arguments based upon the vast stretches of unproductive and non-traffic-supporting country to be crossed. It has become a truism that "facilities create traffic"; the "dream of the visionary" has more than occasionally caught the truth which the statistician could not see.

It needs, perhaps, a long look ahead to justify any of the huge enterprises for "utilising to the fullest, the material resources of the earth." "Such effects are too wide to be judged by the ordinary financial tests. The return to investors measures but a fraction of the total gain." And beyond all this is the politico-economical influence of the great central bond, linking together the whole of the new wealth-producing and manufacture-consuming empire of eastern Africa. No system of disconnected spur lines would serve this development.

* * *

In the opening of the Chicago drainage channel a great engineering work was brought to a successful conclusion in one sense, but it is probable that a still greater engineering problem has only been initiated by the same event. When the sewage of a city of moderate size is turned in a raw condition into a stream, possibly to pollute drinking-water supplies of places below, it is generally done in such a gradual manner that no concerted opposition is made until the evil has grown unsupportable. When, however, the whole drainage of a great city is thrown at once into the waters of a river upon the banks of which

many water works are situated, attention is most forcibly drawn to the magnitude of the injury.

The problem thus raised may be one for the lawyer, but it is certainly one for the engineer. It is of vital importance that every city, great or small, should have a full and complete discharge for its sewage; but it is also of vital importance that no water supply should be poisoned by such drainage. Two things are thus to be accomplished, and both of them are fully within the province of the engineer. The sewage can be rendered nearly, or altogether, harmless, and the water can be effectively purified. Purification plants for the sewage, filtration plants for the water works—these must soon be essential parts of every municipality; and every attempt of one city to dump its filth into the water supply of another should hasten the time when such pollution shall be rendered impossible.

* * *

A good illustration of the part which the designing engineer plays in the adaptation of repetitive processes to practical work is found in the case of a recent invention of importance, which although "made in Germany" was imported to the United States for development there. This machine, an internal-combustion motor of international note, had been carefully designed and constructed by one of the leading establishments on the Continent, and both in appearance and performance it apparently left nothing to be desired.

It was soon found, however, that in design it was wholly unsuited for manufacture on a commercial scale according to American methods, and that it was necessary that it be entirely re-designed—not to improve its performance, but to eliminate the large proportion of hand work involved in the original design, to avoid the necessity for a large portion of highly finished parts, and to adapt it in every respect to commercial production in quantity.

Something has been said in other pages of this Magazine about the revolution in machine-shop practice, but it is evident that if the revolution is to be fully completed the men who design the products must be trained to a complete grasp of the methods by which their designs are to be executed.

* * *

The preponderance of the mechanical side of all branches of engineering, about which comment has been made of late, appears to be continually on the increase. The civil engineer now looks to the workshop for metallic portions of bridges, dams, harbour works, and nearly every detail of his work; the architect has been described as a man who "puts architecture" on structures erected for him by mechanical engineers; and even the military engineer must soon become a sort of fighting mechanic if he is to keep pace with the progress of the profession. A notable instance of this preponderance of mechanical engineering is seen in the fact that two of the most important papers recently presented before the Institution of Electrical Engineers dealt wholly with the mechanical problems connected with the generation of power, including the cost of raising steam, the advantages of different kinds of fuel, the most advantageous arrangements of boilers and furnaces, and all the details of the production of mechanical energy for use in electrical work.

REVIEW OF THE BRITISH PRESS

Cheap Fuel and Electrical Energy.

THE question of the cost of fuel forms such an important feature in the operation of electrical generating stations in England, where water power is only available to a limited extent, that the paper of Mr. R. E. Crompton before the Institution of Electrical Engineers is of much interest.

Mr. Crompton classifies the cheap fuel available for generating electrical energy into three groups. The first includes those in which the calorific value is chiefly in the contained carbon, such as anthracite and small Welsh coals and refuse coke-fuels. There are no great difficulties in burning these fuels, as they are cheap because they are friable, and not because of any great proportion of impurities. The second class of cheap fuel is the free-burning small coal of the Midland districts, only slightly bituminous and with but little tendency to cake, and containing earthy impurities. The third class is the small and dirty bituminous coal of the North; difficult to deal with, but possessing a high calorific value.

The principal difficulty with fuels of the first class is that their finely subdivided condition renders it difficult to prevent a large portion from falling through the grate-bars or from being carried forward into the flues in an unconsumed condition. Special furnaces have been designed to obviate these difficulties, but with only partial success. The attempts to deal with the second and third classes of fuels have been chiefly connected with the use of automatic appliances for distributing the fuel over the bars, breaking up and getting rid of the clinker, and providing sufficient admixture of air at various points in the furnace to ensure satisfactory combustion of the gases.

In many cases these results have been attempted to be gained by the use of automatic stokers, and while such devices operate very well in many instances, yet it is often the fact that the economy effected in stoking is offset by the cost of removing clinker, and by the wear and tear on the grates. Automatic stokers have been most successful with the third, or highly bituminous class, the coal being spread on the front end of the grate, where it is permitted to coke, and then gradually moved back and broken up at the point where intense combustion and radiation is required. Here again, however, the automatic mechanism is seldom capable of contending with the excessive clinker which such fuels form, and much hand labour is required to effect its loosening and removal.

Another method, briefly touched upon by Mr. Crompton, is that of gasifying the fuel in gas producers, and subsequently using the gas under steam boilers. Several forms of producers have been designed for this purpose, including devices for preventing the formation of solid clinker and attachments for the utilisation of by-products. While this application is not extensively considered by Mr. Crompton, it evidently has large possibilities, not so much in respect to the furnishing of fuel for use under steam boilers as for use in connection with gas engines. When it is considered that the modern gas engine, even in small sizes, is vastly more efficient than the steam engine, and that gas engines as large as 1,500 h. p. are now accomplished facts, it is evident that the gasification of very low-grade fuels in gas producers for use with gas engines must be considered as one of the very best methods of utilising such fuels. The fact that this method also affords a perfect solution of the smoke problem is not the least recommendation in its favour.

It has been maintained that the combustion of low-grade fuels under steam boilers involves a general increase in the size of the entire plant, because of the lower heating capacity of the fuel, and that a larger capital expenditure is therefore necessary. Mr. Crompton, however, shows that in the case of externally-fired boilers it is only necessary to increase the size of the furnace, the larger grate area, properly arranged, permitting the combustion of a sufficiently greater volume of the low-grade

fuel as to provide the same steaming capacity as when high-grade fuel is burned upon a smaller grate.

For the low-grade bituminous fuels a travelling grate, based upon the old design of Juckes, is recommended, a firebrick arch being constructed over that portion where the intense combustion occurs, thus affording a storage reservoir of heat to prevent chilling of the fire. In this way a satisfactory combustion may be secured without the necessity for admitting too great an excess of air, with the consequent evil of retarding the combustion by cooling.

Such an apparatus has been introduced by Mr. Crompton at the new works of his firm at Chelmsford, and from comparative tests made during 49 weeks' operation he gives some interesting data.

Using Nottinghamshire steam hard coal of best quality, costing 17s. 5d. per ton, the cost of fuel was 64 per cent. of the total cost of electrical energy, this cost being 0.77d per Board of Trade Unit (kilowatt-hour), while with the cheap low-grade fuel at 5s. 4d. per ton the total cost per kilowatt-hour is given as 0.43d., of which 35 per cent. is for fuel.

It must be remembered, however, that the advantages gained by cheap fuel are only to be expected within reasonable distance of the collieries where it is to be obtained, the cost of transport rapidly neutralising the economy. Mr. Crompton places the maximum distance from the collieries at which these low-grade fuels can be used as within a radius of 50 miles, but it should be commercially possible to transmit the electrical energy generated within such areas to points much further beyond before the advantages due to fuel economy are lost.

Effects of the Manchester Ship-Canal.

THE real value of any great industrial enterprise, such as a railway, a harbour, or a canal, cannot be fully measured by the direct advantage which is gained by the handling and transport of merchandise. Very often these are least of the benefits, and the indirect advantages are nearly always felt before the actual traffic reaches very profitable proportions.

An excellent example of the benefits which accrue to the surrounding country from a great engineering improvement is found in the effects of the Manchester Ship Canal. This subject has been well presented before the Manchester Statistical Society in a paper by Mr. A. Woodroofe Fletcher, and from an abstract in the *Engineer* some of the salient facts are taken.

Prior to the commencement of the canal Manchester was practically in a stationary condition, and, indeed had begun to fall behind. Assessments had fallen off, warehouses were empty, the number of employees in the mills had decreased, and many dwellings were unoccupied.

The beginning of the work upon the canal naturally caused some improvement in the immediate vicinity. A large proportion of the cost of construction expended in wages gave considerable impetus to a number of local trades, while the railways, even before the opening of the canal, made such reductions in their charges as to help many industries which had been affected. After the canal was opened the improvement of affairs which had commenced beforehand, steadily increased, and has continued up to the present time.

The ratable value of the city of Manchester is higher than it has ever been before, notwithstanding the fact that there is no room for more buildings without pulling down the old ones and erecting new ones of greater value. The building of new dwelling houses has been extensive, correspondence has increased nearly 16 per cent. a week, and the increased demand for water, electricity, and gas, has resulted in greatly increased revenues notwithstanding a reduction in rates.

The general saving by the use of the canal itself can only be estimated, but Mr. Fletcher computes that there is a direct annual saving to Manchester of £290,000 by the general reduction in rates, besides a saving of £200,000 a year on the goods which the canal carries itself. Oversea charges have also become less. The rate per ton of 40 ft. from Manchester to Bombay was, in 1892, 23s. 6d.; in 1896 it was 21s.; the rates to the East Mediterranean were reduced by one-third in the same time. Freights to Antwerp, Hamburg, Rotterdam, and other ports have been reduced from 10 to 40 per cent., while in 1896 the North American trade was carried on from Man-

chester at the same rates as those charged from Liverpool; the Mersey Dock Estate having made reductions in their charges of more than 20 per cent.

So far as the canal itself is concerned, each year has shown a good increase in traffic, and from a table given it appears that from 1,358,875 tons in 1895, it has grown to 2,595,585 in 1898, while data for the first half of 1899 show a proportional increase.

Mr. Fletcher is inclined to put down practically the whole of this revival in trade to the Ship Canal. He thinks that few will hesitate to say that, whatever minor forces may have contributed to the general result, the one cause which far outweighs all others is the opening for traffic of the Ship Canal. The period of depression already referred to was attributed at the time to the keen competition to which Manchester was subjected by reason of the cost of transit of goods compared to that to which other manufacturing centres were put. This cause of depression has been largely removed by the canal. "Surely the quickening of local commerce and the revivifying of local industries, which we now see, are not merely the periodical flowing of the tide of prosperity, to be followed at no distant date by a corresponding ebbing of the tide, but they are the signs of a permanent accession of wealth and material well being."

Mechanical Engineering in China.

In view of the general interest of all European nations in the opening of China to commerce and industry, the address of Lord Charles Beresford before the Institution of Mechanical Engineers upon the subject of openings for mechanical engineers in China is especially timely.

Lord Charles is neither an engineer nor a commercial man, but he is a keen observer, well fitted to see wherein opportunities for success may be made, and his remarks, while subject to discussion, contain much that is suggestive.

Naturally the first subject of attention was the development of railways, and with this is included electric tramways, for the ubiquitous trolley has already invaded the flowery kingdom. Although only 317 miles of railway had been constructed at the time of Lord Charles's visit, there were 2270 miles under construction and 2507 miles projected and partially surveyed. This means that in a few years nearly 6,000 miles of track will have been laid, and although extensive works have already been erected at Tongshan under the able supervision of Mr. C. W. Kinder, there must be ample occupation for engineers in the future development of this work. Skilled native labour is by no means cheap, and foreign supervision is absolutely necessary to insure success to any enterprise.

Electricity has mainly been used for lighting purposes up to the present time, but a tramway has been constructed from the railway station to the gates of Pekin, and others will doubtless follow.

The abundance and cheapness of coal should render the installation of electric plants a profitable and important form of undertaking after a short time. Unless Englishmen are prompt, however, much of the vast electrical plant which China will require will come from Japan and America, and it is more than probable that Japanese and American engineers will reap the benefits and opportunities. American electrical plants are prominent in Japan, and the electrical manufacturing industry is rapidly developing there, and the great start which both countries have over Great Britain in electrical work gives them an advantage which it will require promptness and energy to meet.

China is a country of great mineral wealth; coal, iron, gold, silver, copper, mercury, lead, and salt are all to be found in paying quantities, and only skilled workers and the latest machinery are needed to develop the mineral resources of the country. Russia appreciates the importance of the gold deposits in Manchuria, but there are other sections equally rich. The development of mining means a field for nearly every branch of mechanical engineering; motive power, pumping and other hydraulic machinery, electrical power and transmission, compressed air, and all the resources which control the forces of nature for the use and convenience of man, must be pressed into service.

The development of manufactures in China, while it will make an extensive

market for British machinery, will also develop an important competition with British commerce, and of this prospective change Lord Charles has something to say. China will doubtless become a better customer when she has exploited her minerals, and other natural resources, and has more money to spend abroad. Then again an increase of supply increases the demand, and the association which is the result of manufacturing organisation will create a greater demand for articles until now not required. If China becomes an active competitor in some directions she will become a better customer in other lines, so that while individual industries may suffer the general volume of trade will increase. The laws have held good elsewhere, and there is no reason why they should fail in the present case.

One of the greatest defects in such industries as now exist in China is that of imperfect management. The practice is to pay high dividends so long as the business holds out, putting aside nothing for depreciation, and when the inevitable crash comes, it is necessary to lay down a whole new plant. Many of the prominent industries, such as silk and tea, are hampered by old-fashioned methods and appliances, so that much of the silk trade has been taken by Japan, while the tea trade has gone to Ceylon. It seems altogether possible that British companies, established at treaty ports, could buy up large supplies of raw silk and green tea from the Chinese farmers, and, by the use of modern methods, develop extensive and profitable businesses.

Lord Charles emphasises the importance of an acquaintance with the Chinese language, and even goes so far as to recommend the establishment of an engineering school at Hong-Kong, where Chinese could be acquired colloquially at the same time as instruction in engineering, but whatever may be thought of the feasibility of this idea, there is no doubt that the same necessity exists for an ability to speak the language as has been found in other foreign countries where trade has been developed. The main point he emphasises is that English engineers must act promptly and vigorously if they do not wish to see the great opportunities in the Chinese Empire seized by Japan, America, Russia and Germany.

"The potential possibilities of the Chinese Empire are enormous and scarcely to be calculated. To the enterprise, pluck, skill, perseverance and knowledge of mechanics must be looked for assistance in realising the latent resources of that ancient empire, and in keeping the flag of Great Britain ever in the van, no matter in what direction progress is made."

A Mean-Pressure Indicator.

THE term "indicator" as applied to an instrument used in steam engineering has come to be applied almost exclusively to an apparatus for tracing the pressure cycle occurring in a steam cylinder, and all the ordinary forms of the instrument consist essentially of a device which traces a closed curve showing the pressure upon one side of the piston at every point of the stroke. From such a diagram, by measurement and computation, the mean effective pressure may be determined.

Professor William Ripper has devised an indicator of an entirely different sort, although with the same end in view, that is, the determination of the mean effective pressure, and in a recent paper before the Institution of Mechanical Engineers he gives a very complete account of his apparatus.

Instead of giving a diagram of a single cycle upon one side of the piston, Professor Ripper's apparatus records continuously, both the impelling pressure upon one side and the opposing resistance upon the other, and instead of doing this upon a distance-basis it does it upon a time-basis. This result is obtained by the use of two pressure gauges, identical in principle with those used for indicating boiler pressures, these gauges communicating with the steam cylinder through an oscillating or rotating valve so that one gauge is in connection with the cylinder during the out-stroke only, while the other is connected during the return. It is obvious that the gauge which is in communication during the out-stroke receives only the impelling pressures upon the piston, while the other gauge will receive the resisting pressure. Under ordinary circumstances the needles of gauges thus exposed to varying pressures would

show a periodical jumping similar to the motion of an indicator piston, but by partially throttling the openings Professor Ripper has succeeded in reducing this action to a slight trembling, the needle practically remaining steady at a point corresponding to the mean pressure. This is especially the case with high-speed engines in which the impulses succeed each other very rapidly, and it is therefore possible with this apparatus to read off at any time from the gauges the mean effective pressure without delay or uncertainty of computation.

As already explained, this apparatus gives the mean effective pressure upon a time-basis, but Professor Ripper shows that there is but a slight difference between this and the pressure taken upon a distance base. Moreover there is practically a constant relation between the two, and for any given engine, a factor can readily be determined by comparison with diagrams from an indicator of the ordinary type, so that the correction can be made at any time.

The principal points to be observed in the construction of this continuous indicator are the reliability of the gauges and the operation of the valve. The latter is a mechanical problem which may be solved in various ways, and in the author's paper details of some of these are given. So far as the gauges are concerned, there is really no reason why these should be any less reliable than indicator springs when equal care is given to their construction. An important feature in connection with the gauges is the necessity of providing effective water-siphon connections, in order that the gauges themselves may be kept cool. With proper precautions, both as to construction and use, there appears to be no reason why the apparatus should not give entirely reliable results.

Of course such a continuous indicator is not intended to supersede the ordinary instrument, but rather to supplement it, especially in long tests and especial researches. It gives only a very general indication of the working of the valve gear, and affords no permanent record from which the action of the steam in the cylinder can be studied. It does, however, enable the continuous working of the engine to be observed in a manner altogether impossible with any series of ordinary diagrams, however extensive, and avoids the necessity of taking and computing many hundreds of cards.

Since the apparatus must practically be built as a permanent part of the engine, it lacks the portability of the ordinary indicator, but in this respect it may, in many cases at least, come to be regarded as a portion of the permanent outfit to the same extent as the ordinary pressure and vacuum gauges.

Machine-Tool Building.

In concluding an interesting series of papers upon British and American machine tools which has been appearing in successive issues of the *Engineer* a summary is made which lays down some wholesome, if not altogether welcome, suggestions as to conduct in the immediate future. These points are best given in the original words of the writer; which have added weight when the standing and opinions of the journal in which they appear are taken into account.

"To sum the matter up, if we are to maintain supremacy in the machine-tool trade in the future, the following points must be borne in mind:

"(1) A more intimate knowledge of what is being done by others is essential. The time for concealing methods of manufacture has gone by, and a constant intercourse between makers is necessary to stimulate ideas, besides greatly increasing the opportunities of economic manufacture.

"(2) The system of specialising and confining one's attention to a limited variety of work is necessary for the perfecting of any class of machine, and for the reduction of cost of manufacture.

"(3) The principles of trades unionism which tend to limit the capabilities of our working man, destroy his individuality and independence, or limit his capacity for production, must be eradicated.

"(4) Our workmen must be prepared to extend their hours of labour to a number per week at least equal to those of other countries.

"(5) Encouragement must be given to our workmen in suggesting improvements, and any legitimate ambition to better their posi-

tion which they may possess should be cultivated. It is not too much to say that a very large portion of the success achieved by American machinery is due to the efforts of the American working man. Indeed, if the origin of many of the ingenious attachments on their tools be investigated, the larger portion of them will be found to have emanated from the workshop rather than from the drawing office, while a number of principals of the best manufacturing concerns in America at the present day have risen from among the ranks of this class."

While the force of these remarks must be admitted, it is easier to say what should be done than to point out the way to accomplish it. The intercourse among manufacturers and users of tools has already become a fact, and very many proprietors of English engineering establishments have travelled, not only to the United States, but also to the leading works on the Continent, and it is largely to such widening intercourse that the awakening to the necessity for change is due. To carry out the other points, however, will involve a practical reconstruction of works, methods, and social relations. Establishments already equipped for general engineering work are not readily or economically adapted to specialised manufacture. Trades unions have shown themselves altogether unwilling to permit the individuality and independence of their members, and any effort to break the shackles has thus far been unavailing. The absence of class-distinction in America renders possible an individual development and ambition, not so easily stimulated in Great Britain, while the tendency to keep the control of establishments within families, regardless of the ability of the chosen ones to meet the actual conditions; these, and many other facts must be reckoned with in attempting to solve the problem which is before the British manufacturer of machine tools.

Refuse Destructors and Power Plants.

THE great interest which was aroused when the first announcements were made of the successful operation of the Shoreditch destructor and power plant, lends especial value to the account of its second year's operation, as embodied in Mr. C. Newton Russel's paper before the Institution of Civil Engineers.

The complete and cleanly destruction of city refuse is in itself a desirable thing, and when with this a considerable portion of the cost can be borne by the utilisation of the heat, the result is doubly valuable.

The Shoreditch plant has now been in operation long enough for reliable data as to its operative expenses to be obtained, and being the largest yet in use, it is the one to which most attention is directed from those interested in the application of similar principles elsewhere. During the past twelve months this plant has disposed of about 26,000 tons of refuse, 92 per cent. of this being ordinary domestic refuse and the balance being straw, paper, and other worthless material. The plant consists of six water-tube boilers and twelve refuse-furnaces of the Manlove-Alliot type, each boiler being placed between two furnaces, the hot gases being delivered to the boilers by short side flues, special grates also being provided under each boiler on which coal may be burned in case of emergency.

All the handling appliances are operated by electricity, the refuse being raised by electric lifts in the trucks into which it is dumped, and run off by overhead trolley system to the place where it is to be discharged. The average daily amount of refuse handled averaged 84 tons, but the deliveries were so irregular that a storage bin had to be provided to receive the surplus, to be drawn upon subsequently.

No coal has been found necessary for mixture with the refuse, the combustion taking place freely, at temperatures ranging from 1,500° to 2,500° F. The principal difficulty found in the practical operation of the plant was the inrush of cold air during clinkering, and a carefully arranged system of dampers is necessary to avoid chilling from this cause.

The clinker residue amounted to about 32 per cent., and its principal use is found in making mortar-concrete, or when mixed with Portland cement it can be used for making paving slabs.

The general application of the heat from the destructors was for the generation of steam for the production of electrical energy, although a portion was used for local purposes. A small portion of live

steam was supplied for washing purposes to the public baths connected with the station, while the exhaust steam was used for heating the baths and for warming the free library building, no other expenditure for heating being necessary.

Coming to the important question of cost, it appears that the average cost of burning the refuse during the second year was 2s. 6.9d. per ton, this including labour, supervision, repairs, stores and sundries. Evaporative tests of the furnaces show that with one boiler and two destructor furnaces, constituting one unit, burning ordinary refuse, it was possible to evaporate 2,888 pounds of water per hour, from and at 212° F. This corresponds to an evaporation of about one pound of water per pound of refuse. The heating surface of each boiler is 1,300 square feet, the refuse-grate area 25 square feet, and the coal-grate area 27 square feet.

The total amount of energy sold to customers was 1,031,348 Board of Trade Units (kilowatt-hours), the total amount of refuse burned was 26,201 tons, and the coal consumed 1,344 tons—value £1,308 14s. 8d. At Shoreditch the item for interest charges is 1s. per ton, but owing to the location of the destructor this is much higher than might be the case elsewhere.

Superheated Steam.

In connection with the general revival of interest in the question of the advantages to be obtained by the use of superheated steam, the paper read by Mr. J. H. Ashby before the Cleveland Institution of Engineers contains some features of interest.

When the quantity of steam required for the operation of the various engines, pumps, and other machinery about a great iron works is considered, the disproportion between the amount generated and the results obtained shows that there must be great losses somewhere. Attempts to reduce these losses have demonstrated that the greatest causes of waste lie, first, in radiation and consequent condensation in steam mains; and, secondly, and perhaps the greater of the two, in cylinder condensation.

It requires but little observation in any extended iron works to see that there must be much condensation occurring in the number of steam pipes running in all directions from the boiler house to various parts of the establishment, and although the pipes are generally covered with some form of so-called non-conducting sheathing, yet they are generally without roofs, the lagging is often broken, and even in the best protected cases condensation must occur. The extensive business which is done in the manufacture of so-called steam separators, really traps for condensed steam, shows to what extent this form of loss occurs.

The losses from cylinder condensation were early discovered, and the many attempts to reduce it by jacketing show how fully this evil was recognised. Since the first scientific investigation of the subject by Hirn and his followers, various attempts have been made to counteract the loss from this source, and, with the development of multiple expansion, this has been the main line along which improvement of the steam-engine has been sought.

Superheating of the steam, that is, imparting to it a temperature higher than that belonging to the pressure at which it is generated, was early resorted to as a means of preventing condensation losses, but mechanical difficulties prevented the realisation of success. It was found impossible to secure the desired temperature without carbonising the lubricants then in use, and the superheaters, being weakened by excessive heat, gave out, sometimes with disastrous consequences.

With modern lubricants, and improvements in construction, superheating has again come to the front, and from the experience of steam engineers, at first in Alsace, followed by experimenters in other countries, valuable results have been attained.

The best location for the superheater has been a matter of some discussion, and while early practice indicated the discharge flue from the boiler, it was found that the low temperature of the gases at that point rendered large surface necessary if the desired temperature was to be attained. If, on the other hand, the superheater was placed too near the furnace, fluctuations in temperature occurred, and the apparatus was injured by overheating. An inter-

mediate position is probably to be preferred, and in some forms the whole apparatus is now set entirely apart from the boiler, a separate furnace being employed. In every case provision should be made for protecting the heating surface from injury should the flow of steam not be sufficient to carry off the heat, and in some forms the superheater is so arranged that it can be flooded with water while steam is being raised in the boiler, and subsequently cleared and thrown into the steam circuit.

Assuming that the mechanical difficulties, both as to the superheating and using have been successfully overcome, the economy to be obtained by superheating appears to have been fully demonstrated.

The experiments of Unwin and Kennedy in England, and of Schröter, Schmidt, and others, in Germany, show that with 100 to 150 degrees of superheating an economy of 15 to 20 per cent. may be attained. Indeed, in Germany Schmidt offers to guarantee with steam superheated 150° C., a steam consumption of only 3.8 to 4 kilogrammes (8.36 to 8.8 pounds) of steam per horse-power-hour!

In view of the moderate success which has attended other attempts to reduce condensation losses, the advantages of superheating certainly demand attention. There is no doubt that modern lubricants are entirely capable of resisting the effects of the high temperatures, and with metallic packings, and high-class workmanship there should be no trouble in applying steam as highly superheated as may be necessary to secure freedom from serious initial condensation.

The Cost of Calcium Carbide.

SINCE the first commercial introduction of acetylene as an illuminant it has been recognised that the extent to which it could come into general use would depend upon the cost of the prime material in its manufacture, calcium carbide. As this material has only been successfully produced by means of the electrical furnace, the cost was early seen to be dependent upon that of electrical energy, and it was not difficult to compute the theoretical amount of power required to produce a given weight of carbide. This computation was made by several individuals, with results substantially agreeing, and ranging from 2 to 2.37 horse power hours per pound of carbide.

It was, however, understood, of course, that a lower efficiency was to be expected in practice, and it is only after a period of definite experience that the commercial efficiency of the process could be determined.

Taking such data as are now available, the subject of the actual cost of calcium carbide is discussed in a recent issue of *The Engineer*, and a summary of the results in various localities will be of interest. So far as the efficiency of the process is concerned a comparison of various data indicates that about 60 per cent. of the computed output may be expected; the mean of several reports giving 8,744 h.p. hours as necessary for the production of one long ton of carbide, instead of the theoretical 5,208 h.p. hours.

The question is therefore mainly one of the cost of power, and this is plainly shown by the fact that all plants where carbide is produced in any commercial quantity are placed where cheap water-power is available. Since practically all of these plants are situated out of England the data must be taken from reports published elsewhere. Thus in Switzerland steam power is given as costing £11 or £12 per year, while water-power does not cost above £1, in favoured localities. At Foyers water-power costs nearly £4 per h.p. year, and in England steam is assumed at about £9 per year.

The other factors in the total cost, *i. e.*, material, labour, depreciation, interest, etc., can be computed in much the same manner as in the case of any other manufacturing plant, and from a tabulated estimate for a plant of 1,600 h.p. made by Ludwig, these are shown to amount to about £5 per ton.

Since it is impossible to assume that a horse power year can be produced cheaper in England than £4, and will more probably cost £9, it will be evident that the cost of carbide per ton may be placed anywhere between £9 and £14, according to the cost of power.

Review of the Continental Press

Electric Power in Mining.

In no branch of stationary power application is electric driving meeting with greater favour than in mining work, the ease of subdivision and the facility with which connection may be made with various workings, rendering electrical transmission especially suitable for underground workings.

A paper upon some applications of electric power in various parts of Austro-Hungary by Herr Arthur Bloemendal, in a recent issue of *Stahl und Eisen,* gives an excellent idea of the methods in use on the Continent, and as it contains some details of practical work in large mines in Bohemia and Hungary, especially in connection with the use of polyphase currents, a brief review will be of interest.

The applications of power in mining are diversified, but naturally the greatest proportion is devoted to pumping and hoisting, although in some instances ventilation demands much power, while in coal mining electric coal-cutting machines are coming into very general use.

Herr Bloemendal gives, as an example of the satisfactory working of three-phase currents in mining work, the installation at the Nelson Shaft No. III., at Brüx, where a three-phase generator of 200 kilowatts supplies current for a motor operating a ventilating plant at a distance of one kilometre. The use of electrical transmission in this case enables the generator to be placed in the main power-house and also avoids the expensive hauling of fuel to the inconvenient location where the ventilating shaft is situated.

Several instances are given of the advantages of electric transmission over the use of steam pipes for pumps, not the least being the reduced loss in transmission. The heat from steam pipes is often very objectionable, while for pumps which require to be frequently moved, as is the case in development works and shaft sinking, electricity has been found most useful. At the Budweis colliery a traveling pump was required to be operated on a track inclined at an angle of 23° from the horizontal, and to traverse a passage only 1,300 millimetres high and 900 millimetres wide, and at the same time a capacity of 400 litres per minute against a head of 240 metres was required. It would have been impossible to fulfill the conditions by the use of steam or compressed air, but a very satisfactory electrically-driven pump was designed and is now in use.

Pumps for use in shaft-sinking are operated with great advantage by electricity, especially because of the ease with which the current can be delivered to the suspended mechanism. By providing a cable drum at the mouth of the shaft, the conductor can be fed out as the shaft descends, and thus all the inconvenience formerly experienced with steam pipes is avoided, especially the leakages at imperfect joints and the delay incident to the insertion of new lengths of pipe.

For all such applications of electric power the polyphase current is found to be satisfactory, but for general traction purposes the continuous current is still preferred. For this portion of the plant the polyphase current can be conveyed to advantage to the point near the operation of the haulage tracks and then, by use of a rotary converter, transformed into the desired continuous current.

Herr Bloemendal gives a description of the plant at the Hernadthal Iron Works, at Krompach, in which a polyphase current of 3,000 volts pressure is transmitted over a distance of 6 kilometres by uncovered wires on wooden poles, and there transformed to a continuous current of 500 volts for operating a mine haulage plant. A portion of the polyphase current is also transmitted a further distance of 2 kilometres, and transformed for use in electric rock drills.

There has been some doubt expressed as to the reliability of electric machinery in mines, and, as the results of breakdowns may be most serious, this is an important

question. The greatest cause of trouble has been that of short-circuiting, due to defective insulation, but the improvements in insulating materials have rendered accidents from this cause quite remote in new installations, while, with proper care in mounting and supporting conductors, there is no occasion for insulation to become seriously damaged in operation. Motors and generators are now made so as to be practically unaffected by dampness, and Herr Bloemendal gives an example of a generator directly connected to the shaft of a Pelton water-wheel and placed in an underground chamber where the moisture was so excessive that water was constantly trickling down the walls. Although the dynamo was of the open type, no trouble was experienced during a period of more than a year and a half.

So far as the ignition of mine gases from sparking is concerned, this portion of the problem has apparently been met by the production of non-sparking dynamos, and the advantages of electric lighting are such as to render electricity safer than the older methods.

Liquid Carbonic Acid.

CARBONIC acid was one of the first gases to be liquefied by pressure, the gas for this purpose being generated from marble dust and chips by the action of a dilute acid, sulphuric or hydrochloric; the gas which is used for the production of carbonated drinks still being generally produced in this manner. The convenience of the liquefied gas for such purposes, is such that it has become a regular commercial product, being generated and compressed in cylinders in portable form.

A recent issue of the *Moniteur Industriel* contains an account of the installation of a plant at Rouen for the purpose of collecting the carbonic acid gas given off during fermentation in breweries and distilleries, thus securing what has hitherto been considered as a waste-product, and making it of commercial value.

The idea of utilising this waste product originated with M. Louis Meeus, of Wynghem, and the method has been put into practical operation in a large distillery, producing 300 hectolitres (nearly 8,000 gallons) of alcohol per day. It has been computed that in this establishment the daily production of carbonic acid is 28,000 kilogrammes (nearly 62,000 pounds), all of which has been therefore permitted to drift away into the atmosphere. By a system of exhausters this gas is now collected and delivered to compressing pumps, by which it is liquefied under a pressure of 55 atmospheres, the liquid being collected in steel cylinders of 10 kilogrammes capacity each. The liquid gas, thus collected, can be shipped like any other merchandise, and in this form it is well adapted for all the commercial operations which have generally been accomplished by gas manufactured on the spot.

The advantages of such a convenient supply may revolutionize certain industries, such as the charging of siphons, the local production of intense cold, and the carbonating of various drinks, and the recovery of this by-product may therefore be a matter of material industrial importance.

Mining Machinery in the Transvaal.

THE rapid development of the mining interests in the Transvaal has made that section probably the best equipped mining region, so far as modern machinery is concerned, to be found anywhere. This evidence of the possibilities of the region from an engineering standpoint, is well brought out in an article by Herr Kurt Schweder in a recent issue of *Glückauf*.

Herr Schweder emphasises the fact that, great as is the importance of the mining interests of the Transvaal, a recent visit to the country convinced him that as a field for the application of modern machinery the opportunities are at least equally great.

According to the statistics of 1898, there were at that time in operation in the Witwatersrand district, 1,593 steam boilers, 294 engines, for general motive power, 407 hoisting engines, 133 air compressors, and 222 pumps.

Water-tube boilers seem to have found favour, and several well-known types of German and American design are in extensive use. The coal used is inferior, an evaporation of 7 pounds of water per pound of coal in the calorimeter being about as good as can be obtained, the minimum proportion of ash being about 30 per cent. In practice it is found that only

about half the usual guaranteed evaporation can be obtained, as compared with the performance of similar boilers with suitable fuel elsewhere, and this fact should be borne in mind in making plans for steam plants. Herr Schweder advises that an evaporation of only about 60 per cent. of that shown possible by coal analysis can be expected in practice.

It is urgently recommended that feed-water purifiers be used, as the mine water is charged with sulphates and also contains much mud and sediment. The importance of this fact was not fully realised until after many boilers had been seriously damaged by heavy formations of scale.

Chimneys are usually made of sheet-iron, being built in sections and erected with the aid of wooden scaffoldings, and finally strengthened by wire guys.

Air compressors have been extensively used since the time of the early workings, being necessary for the operation of rock-drills, boring in the hard reef. The earlier compressors were constructed with heavy cast-iron flap-valves, but the later designs of the best American and German makers have since been installed, with mechanically operated valves, so that probably the latest developments in this important branch of engineering are best represented in South Africa.

For motive power many excellent types of engines are in use, various modifications of the Corliss engine being seen. These are operated with much care, indicator cards being taken daily and entered with accompanying data in a log book as a portion of the records of the plant. High-speed, direct-connected engines of the Willans type are much used in connection with dynamos for electric plants, although in a few instances slow-running engines are also found in use for this purpose.

The stamp mills are generally driven by direct-connected engines in order to avoid the difficulties arising from unequal settling of foundations, but in some instances a flexible rope transmission is used, employing Manila or cotton rope.

Pumps are found in great variety and number. In some cases the service required of pumps is difficult and exacting. For the handling of the tailings from the copper plates pumps were first used, but it was found that the sand present in the water cut the valves, cylinders, and plungers to such an extent that bucket wheels had to be substituted. For handling slimes centrifugal pumps have been found very satisfactory.

In regard to mine pumping, no very great difficulty has been experienced with volume of water, indeed it might be advantageous if there were a greater flow, in order to dilute the acidity, since at present the mine-water contains 0.04 per cent. of sulphuric acid.

Winding engines are naturally important in a region where such great depths have been attained. The operations of these engines are controlled by a number of levers, not only for the operation of the engines themselves, but also for the control of clutches, brakes, and disconnecting gear. Much experience and skill is required of the engineers in charge of these machines, and for the past three years the Transvaal government has required men aspiring to such positions to pass a special examination, the strictness of which may be inferred when it is stated that in the last year only 56 out of 112 applicants succeeding in passing.

The present disturbed condition of affairs in this important mining country will doubtless soon give place to renewed activity in mining operations, and with it must come a demand for general and special machinery of the highest class, and in this connection the experience of Herr Schweder will be found a valuable guide.

The Mont Blanc Railway.

THERE has been some talk at various times about a railway to the summit of Mont Blanc, and now we have, in a recent issue of the *Moniteur Industriel*, a detailed account of the scheme, which may form one of the striking achievements of the coming century.

The starting point of the road is intended to be at Les Houches, close to the line from Fayet to Chamounix, now in course of construction, and the road will enter a tunnel immediately below the village of Taconnaz, at an altitude of 1,100 metres. The line will then follow the ridge along the left side of the glacier of Taconnaz, and by a tunnel 5 kilometres in length will reach the

summit of the "Aiguille du Goûter." This tunnel, running up along the mountain ridge, will be pierced with openings at various points along the side, the whole forming a magnificent rocky gallery affording views of the peaks and glaciers surrounding Mont Blanc. At the summit of "Aiguille du Goûter" there will be a large railway hotel, which, situated at an altitude of 3,843 metres, will be provided with all the necessaries for protracted sojourns, and is expected to become a popular resort. From this station the excursion to the glacier will start, and from here a tunnel will be driven directly under the "Dôme du Goûter," in the direction of the Vallot observatory, where a station is to be established at an altitude of 4,362 metres, on the "Rochers des Bosses."

In order to reach the Janssen observatory the road must be conducted under the Rochers des Bosses, reaching the Rochers-Rouges, where, at an altitude of 4,580 metres above the sea, the terminal station will be situated. This point is only 230 metres below the summit of Mont Blanc, and from here an inclined cable-railway will be used to enable the last portion of the journey to be completed, and the final altitude of 4,810 metres attained.

The total distance traversed by the rack railway and the cable road will be 10 kilometres, and it is now estimated that by the month of July, 1902, tourists will be transported to the "Dôme du Goûter," an altitude of more than 3,508 metres.

It is proposed to make the terminal station entirely underground, with alcoves excavated in the rock for restaurants and other industries, the whole thus being entirely sheltered from the exposure to the cold and atmospheric disturbances incident to the great altitude.

Such is the outline of the scheme proposed by the French engineer, M. Saturnin Fabre, and in view of the success which has attended the existing Alpine railways there seems to be no good reason why it should not be realised, if the financial side of the problem can be successfully met. The railway to the summit of the Jungfrau is now well under way, and offers difficulties not less imposing than those which appear in the Mont Blanc scheme, and the popularity of the region among tourists from all parts of the world should render this project equally attractive from a commercial point of view, if the constructive cost is not prohibitive.

By the use of electricity as a motive power, derived from the ample sources of hydraulic power in the vicinity, the expense of transporting coal will be avoided, practical experience with electric mountain roads having fully demonstrated the success of electric power for this work.

The Mont Blanc railway, with its observation galleries overlooking the valleys of Chamounix and Sallanches, and with its panorama of the whole of the French, Swiss, and Italian Alps, cannot fail to be a point of attraction for travelers from all parts of the world, and it is to be hoped that the plans for its construction will meet with a successful realisation.

The Transformer Turbine.

THE advantages of the direct connection between turbine and electric generator have been abundantly shown in many modern hydraulic electric stations, and either in the vertical or horizontal form this arrangement has become generally approved. When, however, the head of water available is not great, it is not practicable to attain a sufficiently high rotative speed upon the turbine shaft with the ordinary construction, and in such instances it has been usual to interpose some form of gearing to obtain the desired speed.

In a recent series of papers in the *Schweizerische Bauzeitung*, Professor Franz Prásil of the Zurich Polytechnic, discusses what he terms the "transformer" turbine, and shows the practicability of obtaining from low heads sufficiently high rotative velocities to permit of the use of direct connected dynamos.

The principle upon which this apparatus is constructed is that of a form of what may be called "hydraulic gearing," the compound motion of two co-axial wheels being united and hence multiplied in corresponding proportion. This is accomplished by causing a portion of the water to flow through a wheel of the Jonval type, which wheel, revolving, carries with it a set of guide vanes which direct the balance of the water against the buckets of the main turbine below. This last tur-

bine is thus fed, not from stationary guide-vanes, as in the ordinary Jonval wheel, but from vanes which are already in motion, and hence it receives the sum of the motions of both systems.

The geometrical relations of the various parts of this combination are very fully worked out by Professor Prásil, and in conjunction with Herr Naville, the chief engineer of the well-known firm of Escher, Wyss & Co., some wheels of this type have been constructed and tested.

A very full account of the tests is given in the paper, and the data and results are tabulated and shown in the form of diagrams, but a general summary only can be given here. The testing weir of Messrs. Escher, Wyss & Co. was used, so that every facility for the measurement of head, speeds, brake power and efficiency was available. The head of water varied from 2.7 to 2.84 metres, and the power developed at full gate was nearly 40 h.p. Under these conditions the speed attained by the single turbine was about 70 revolutions per minute, while the transformer wheel practically doubled this, reaching 131 to 134 revolutions.

The efficiency tests do not show as high results with this form of wheel as with the best examples of single turbines, reaching only about 54 per cent., but this feature is doubtless capable of further improvement. and when it is considered that the losses due to gearing are avoided it is a question whether the commercial efficiency is not as great in one case as in the other.

This novel departure in hydraulic motors, while special in its nature, may find numerous applications, and its development will be watched with interest.

Deepening Mine Shafts.

In the coal regions of Belgium many difficulties have been encountered in sinking the shafts to much greater depths than were originally intended or expected. For this reason the account of the methods recently adopted, as described in a paper by M. Julien Linet in the *Revue Universelle des Mines,* is of especial interest, and the system there shown may find equally satisfactory application elsewhere.

The principal difficulty encountered was that of the character of the strata through which the shafts were to be sunk, requiring the lining to be substantial. The coal measures have a dip of 50° to 75°, and between them are strata of schist and sandstone of varying degrees of solidity, with occasional veins of water.

The especial shaft discussed in the paper was an air shaft, carried down parallel to the vertical hoisting shaft of the mine, and it was desired to increase its depth from 480 to 580 metres, or a deepening of 100 metres. This work may broadly be divided into two portions, the excavating and the lining, and it was mainly in the latter portion that the method discussed was employed.

The excavating called for no especial devices, hand drills being employed, and the blasting being performed by safety mining explosives fired by electricity. The débris was raised in steel skips of about 0.15 cubic metre capacity, by the use of a steam windlass.

During the first 50 metres of the work the lining of the shaft, which was to be 3 metres internal diameter, was composed of brick work masonry, a temporary bracing being employed to support the sides from caving during the work. This bracing was composed of circular frames made of channel-iron and provided with struts arranged in such a manner as to leave a central opening of sufficient size to permit the hoisting of the skips. As the deepening progressed the brick lining was constructed in the usual manner, the iron bracing rings being lowered to the deeper portions of the excavation.

This system of masonry lining has generally been considered the best for colliery shafts in Belgium, but it has various disadvantages. It is expensive; it is not rapidly executed; and it is by no means impermeable. For these reasons, as well as because it was thought most desirable to be able to carry the lining down simultaneously with the excavation, it was determined to attempt to improve upon the brickwork lining for the second 50 metres of the work.

The idea was to carry down a continuous lining of concrete in such a manner as to form a complete monolith when the shaft should be finished, and it was in the

execution of this plan that the especial interest of the work appeared.

In order that the concrete should form a continuous mass it was necessary to have the work proceed regularly, step by step, in such a manner as to be practically continuous, and this involved a movable centering supported in the middle of the excavation, with a space between it and the earth walls in which the concrete could be rammed. This movable centering, which was 3 metres in diameter and 1 metre long, was formed in segments in such a manner that by releasing one portion, the whole could be contracted and loosened to a sufficient extent to permit its descent. The excavation was kept in advance of the centering by 3 or 4 metres, no difficulty being experienced from caving-in within this space, and as soon as the débris was removed the centering was lowered and the concrete filled in.

During the filling the centering was supported on wooden beams braced across the excavation, while the concrete, lowered in buckets, was carefully rammed into the annular space. It was found that the concrete was thus forced into the irregularities of the excavated walls in such a manner as to be firmly attached at once, so that there was no danger of movement when the centering was shifted, and the work proceeded rapidly as soon as the workmen acquired experience in the method.

The concrete was made from slag cement, which gave excellent results under test, and which was much cheaper than natural cement at the locality. The concrete was composed of cement, granulated slag, and pebbles in the proportions of 1 : 2½ : 4½ ; tests of this combination showing a crushing strength of 300 kilogrammes per square centimetre (4.266 lbs. per sq. in.).

A comparison of the advantages of the concrete lining and that composed of brick masonry is given by M. Linet, and as it is made upon two sections of the same shaft the other conditions were so nearly equal that it may fairly be considered as showing the relative methods of the two systems.

The economy, which was shown to be largely in favour of the concrete, was dependent upon several elements. Lower-priced labour could be used, more rapid progress was made, and the material cost less. The details of the cost and progress of each system are tabulated in the original paper, but the general results are best shown by the conclusions, which are as follows:

1. A daily progress, both as to excavating and lining, of 29 per cent. greater speed with concrete than with brickwork masonry;

2. An economy of 82 per cent. in the cost of labour;

3. An economy of 148 per cent. in the cost of material.

Since this shaft was intended for a ventilating passage, another important advantage appears in the smoothness of the surface, this reducing the frictional resistance, there being no joints or other roughness to impede the flow of air.

The success of this work may lead to its general adoption in Belgium, and the method is certainly worthy of consideration elsewhere.

The Wear of Gear Teeth.

THE correct form of gear teeth is a subject to which probably more study has been given than almost any other detail of machine design, and from the time which is given to it in some courses of study it might almost be supposed that the tracing of tooth-outlines was the main object of the mechanical engineer. In all these studies, however, one important feature of gear tooth action has hardly been considered, namely, the influence of the shape of the tooth upon the wear. Several years ago a paper upon this feature was presented before the American Society of Mechanical Engineers by Professor Reuleaux, and now we have a very full treatment of the same subject in a series of papers by Herr O. Lasche, in the *Zeitschrift des Vereines deutscher Ingenieure*.

The importance of this matter is shown by the fact that electric traction and other applications of electric driving have led to a much wider introduction of high-speed gearing than has heretofore been made, and in many instances these applications are surrounded by conditions which conduce to rapid wear.

It is evident that the question of wear

compels the consideration of many other conditions than those involved in the mere kinematic problem of the transmission of motion at a determinate velocity-ratio, the wear depending upon the pressure on a given unit of tooth surface, upon the extent and nature of the sliding, and upon other working conditions to be considered in each specific case.

Heretofore the best form of tooth outline has been decided solely by the theory of geometrical relation of the parts during the transmission of motion, but when the question of wear is taken into account it will be seen that the form of tooth may have an important influence upon the life of the wheel.

The two forms considered by Herr Lasche are the epicycloid and the involute, these curves, or some close approximation to them, being practically the only ones in general use. Assuming that these are practically equal, so far as ease of construction and correctness of transmission of motion are concerned, he takes up the difference in wear in each case, giving some very interesting and instructive diagrams. The wear may be considered as dependent upon the following three conditions: the specific pressure of the two tooth-surfaces upon each other, the coefficient of friction of the materials used, and a coefficient depending upon the extent to which the two surfaces roll and slide upon each other.

Assuming the total pressure to be uniform during any period, the specific pressure depends upon the area over which the total pressure is distributed, and it is evident that this area is governed by the curvature of the surfaces. If the materials were absolutely inelastic there would be but a line-contact in any case, but in practice the area of contact depends upon the elasticity of the material and the radius of curvature of the surfaces. Since the curvature is by no means constant for either form of tooth, it follows that the specific pressure varies during different portions of the engagement of the teeth, and there will be variations in wear upon different portions of the tooth from this cause.

The question of relative sliding and rolling action is carefully studied by Herr Lasche, large diagrams of teeth of both forms being shown with the faces divided so as to show the extent to which the sliding occurs, and the relative results being plotted in the form of curves. Similar curves are given to show the varying pressure at different points of engagement, and by combining the two curves the extent and distribution of the wear can be theoretically deduced. From these it is seen that the wear on involute teeth should be much more irregular than of epicycloidal curves, the pressure and rubbing being especially high at the beginning of engagement in the case of the former.

Comparing these theoretical conclusions with the behaviour of teeth in practice it will be seen that the theory is well borne out. A number of photographs are given of gear teeth which have been badly worn in service, and the distribution and extent of wear in the two systems show that it is quite possible to determine beforehand the character of action for a given form of tooth, so far as durability is concerned. The question of the "coefficient of wear," first introduced by Reuleaux, is a matter which should undoubtedly be taken into consideration in connection with the whole subject of gear design for such service as is involved in tramway work, and with an intelligent study of the subject a much longer life for gear wheels may be expected.

Hydraulic Power in Italy.

SEVERAL months ago the question of the importance of the development of its numerous water powers upon the industrial future of Italy was discussed in the leading pages of this magazine by Signor Enrico Bignami, and now we have an extended discussion of the same subject by Ing. A. Raddi, in the pages of the *Giornale dei Lavori Pubblici*.

After showing the importance of the utilisation of natural sources of power in a country destitute of coal, Signor Raddi goes on to discuss the feasibility of long-distance electric-power transmission, especially in view of the recent propositions of Professor Forbes; and in the same connection he shows how successful have been the great Italian hydraulic-power plants near Rome (Tivoli), Genoa (Gorzente), Paderno, and Vizzola. He then takes up a

phase of the subject, which, so far, is peculiar to Italy, namely, the Government regulations controlling the utilisation of hydraulic power.

This forms an important feature of the problem, since the granting of water rights has become somewhat involved, and consequently the development of hydraulic power proportionately impeded.

In order to prevent valuable water rights from being taken up and held speculatively under certain older regulations, a circular was issued by the Minister of Public Works in 1898, requiring concessions to be withheld until certain official investigations had been made, especially with a view of ascertaining the possible value for governmental purposes. Subsequently to the issuance of this circular and its later withdrawal, a new law has been drawn up which provides for the supervision and regulation of hydraulic-power concessions, the especial point in view being that of the development of national industry rather than the immediate production of revenue by taxation. So far as the present industrial condition of the country is concerned the importance of such action will appear when it is realised that 4,000,000 metric tons of coal are now imported annually, representing a value of 120,000,000 lire in gold.

The total amount of power available is computed broadly from the best statistics as that producible from 1,000 cubic metres per second, with a mean fall of 600 metres, or 8,000,000 h. p., or, if a number of small streams are included, this may safely be increased to 10,000,000 h. p. Of course no accurate estimate can be made until the available streams have been fully surveyed and mapped, and although this work has been authorized by the Government, it has only been carried out to a very small extent up to the present time, but this estimate agrees very closely with that made by MM. Gillian and Blondel for France in 1898.

Signor Raddi gives an interesting discussion of the question of the cost of a hydraulic-electric horse-power, and incidentally of the cost of a steam horse-power, and in view of the interest which has attached to similar discussions elsewhere his conclusions are here abstracted.

Assuming that with modern steam engines of 50 to 100 h. p., the coal consumption is 1 to 1.2 kilogrammes per h. p. hour, the cost of a steam horse-power is found to range between 1,450 lire for a one horse power engine, to 150 lire for a 500 h. p. engine, per year of 3,300 working hours.

The cost of an electrical horse-power naturally depends more upon the cost of installing the permanent plant than upon the subsequent operating expense, and to this cost of building, fixtures, machinery, etc., must be added the very variable cost of the dam, canal, and tail-race. In Italy the rapid falls cause the conditions to resemble somewhat those existing in Switzerland, and from the existing plants in Germany and Switzerland, together with those which have thus far been erected in Italy, an average cost may be deduced which will serve as a basis for future estimates. Thus the plant at Zurich, according to Saldini, cost 500 lire per h. p. at the power house, or including the cost of the electrical plant and the transmission to Zurich and Winterthur, 1,200 lire, this not being a very low cost. The plants at Paderno and at Vizzola have cost, for the hydraulic works and power house alone, about 600 lire per h. p., and from 1,000 to 1,200 lire including the electrical portion. From such data the cost of the plant proposed on the Magra for the supply of electrical power to the arsenal at Spezia, has been estimated at 1,500 lire per h. p. for a capacity of 1,700 h. p. total. Much lower costs than these are possible when the power house is situated in the mountains. Thus the plant on the Isère cost only 170 francs per h. p., and one in Haute Savoie of 6,000 h. p. from a fall of 140 metres cost but 83 francs per h. p.; but unless the industrial operations are such as can be economically conducted in such localities, the cost of transmission may render the final economy not much greater than more expensive plants in better commercial locations. For metallurgical operations, and for some electro-chemical works, however, it may be found equally convenient to have the works situated in the mountains, and the increased cost of coal in such localities adds to the comparative advantage of hydraulic power.

REVIEW OF THE AMERICAN PRESS

Electric Power Stations in New York.

THE development of the electric power station, especially in connection with electric traction systems, is strikingly shown in the case of New York City, where there are now under erection two of the largest steam-electric power plants in the world, and from accounts in the *Engineering Record* and the *Street Railway Journal* some description of these latest examples of power-house work is abstracted.

The determination to concentrate the power of a system at a single large station is the outcome of the development of the polyphase system of electrical generation. The 500 volt direct current system would have involved the erection of a number of stations at various points, as it would have been practically impossible to transmit the current over the 220 miles of system, but by the generation of polyphase alternating current, transmitted at a high voltage to distributing points where it can be reduced to a 500 volt direct current by means of rotary converters, the giant power station has become a possibility.

The station of the Metropolitan Street Railway Company occupies an entire block between 95th and 96th streets on the East River, thus permitting the delivery of coal direct from barges to the bunkers over the boilers. The proximity to the river also permits an abundant supply of water for condensing and other purposes; the only objection being that the saltness of the water prevents its use for boiler feed, rendering surface condensers necessary.

This plant, of which a very complete description is given in the *Engineering Record,* contains 11 units aggregating from 45,000 to 60,000 h. p., the latter being the maximum and the former the most economical load. The construction of these large compound engines is well shown in the illustrations to one of the leading articles in the January issue of this Magazine, especially as photographs are given of the work as partially erected, and the fact that this plant represents the typical practice now attracting so much attention and discussion in Europe lends especial value to the publicity which has been given to it.

The general arrangement of the power-house presents no wide departure from standard American practice, the use of water-tube boilers in successive stories, with coal bins above, and with mechanical conveyers for coal and ashes, being well known and approved. The main interest, other than that which attaches to the size of the plant as a whole, lies in the massiveness of the engines, these being provided with shafts of fluid-compressed steel, hollow-forged, 37 inches in diameter at the fly-wheel, 34 inches at the journals, and 30 inches at the cranks. The dimensions of shafts and bearings which American experience has found advantageous has been made the subject of some discussion abroad, but it must be remembered that stiffness as well as strength must be considered. In the case of marine engines, the conditions are so different as to create no precedent which can apply, the load being almost altogether such as to produce torsional stresses, while in the power-house engine a very heavy lateral stress is produced by the weight of the revolving fields and heavy fly-wheels. When in addition to this it is remembered that a very slight deflection is sufficient to destroy the magnetic balance, it will be seen that there is good reason for the adoption of dimensions which at first appear to be excessive.

The other station to which reference has been made is still larger, being intended for a capacity of 100,000 h.p., this being the new power house of the Third Avenue Railroad Company, of New York. This station is but recently commenced, but the plans for the buildings and equipments are very fully given in the *Street Railway Journal,* so that the two plants may be fairly well compared.

So far as the engines and generators are concerned there is little to be said, as the standard practice above described has also been adopted in this case, there being

16 direct-connected cross-compound engines of 4,500 to 7,000 h.p. capacity, with the fly-wheel directly attached to the revolving member of the generator.

The main feature of this plant lies in its subdivision into four sections of four units each. Each section is served with steam by a double-decked battery of boilers occupying one-quarter of the boiler house. Each quarter in turn has its independent flues, economizers, stack, auxiliary mechanical draft, and condenser. Equalizing flues are provided, to allow each stack, with the aid of mechanical draft, to relay the other stack on the same side of the house. The steam piping, constructed upon the equalizing-main system, is so connected as to allow each section to relay each of the other three, while the four condensers are so multiplied together in their connections as to work as one unit, three having the requisite capacity to admit of one being cut out. This arrangement gives practically four plants, capable of being operated as one homogenous plant, the advantages of which will readily be seen.

Both plants are equipped with mechanical stokers, it being found advantageous both for mechanical and administrative reasons to be free from the difficulties of hand-firing. The stokers, being adapted to use either hard or soft coal, separately or mixed, obviate to a great extent the possibility of interference or delay by reason of strikes or combinations among coal miners, and the avoidance of the necessity of employing a small army of firemen who might in case of labor troubles interfere with the continuous working of the plant. The Third Avenue plant contains, among other improvements, the use of central condensing apparatus, instead of the provision of a separate condenser for each engine, and plans have also been made for a very complete system of oiling from tanks, using pumps for the movement of the oil and filtering and cleaning devices for the return oil.

The extent to which central station practice has grown in America is hardly appreciated in other parts of the world, and an examination of these accounts of the two largest and latest installations will furnish much information concerning present practice on a large scale.

The Lawrence Sewage Experiments.

SANITARY engineering has become greatly indebted to the Massachusetts State Board of Health, not only for the many valuable investigations which it has conducted, but also for the complete manner in which the results of such work have been made public, and the reports of this body are filled with valuable information concerning original work.

The report for 1898, which has been recently issued, contains some valuable information concerning the treatment of sewage, based upon investigations which have been carried on at the Lawrence experiment station, and from an abstract of this portion given in the *Engineering Record* some points are taken.

The Lawrence experiment station has been in operation about 11 years, and during that time it has made several hundred investigations of sands, soils, etc., in connection with the chemical and bacterial analyses of sewage, to assist in the construction of sewage disposal plants in various towns and cities of the state.

Since the development of the septic processes, in England and elsewhere, a septic tank has been constructed at Lawrence, and it is upon the behavior of sewage which has undergone septic treatment and is subsequently passed to various filter beds that the present report mainly treats.

There are several points which must be considered in discussing sewage purification. The object of the purification is to convert the organic matter into inorganic matter. The first action is that of the dissolved oxygen, which oxidizes the carbon, while the hydrogen and nitrogen form ammonia. When the oxygen is exhausted putrefaction sets in, the organic matter continuing to break up into simpler combinations, but producing hydrogen compounds with sulphur, phosphorus, and carbon and consequent foul odors.

The final break-up of the organic compounds is effected by bacterial decomposition, which takes place in properly constructed filter beds, such beds being composed of sand, cinder, or coke, the passage of the liquid through the finely divided material enabling the bacterial action to take place more or less completely. One of the difficulties with such filters has been

the formation of a scum of organic matter upon the top, this preventing the ready descent of the liquid into the lower layers of the bed. The experiments at Lawrence give information as to the action of the septic tank in rendering the greater portion of the organic matter soluble, and thus providing a material much better adapted for treatment by the filter beds.

The tank at Lawrence is an air-tight wooden box divided into two compartments by a central partition, the sewage flowing into one side, over the partition into the other. After the sewage has remained in this tank for 24 to 36 hours it is drawn off, and it is found that the amount of suspended nitrogenous matter has been reduced about one-half and is much more finely divided. The albuminoid ammonia is decreased by about 48 per cent., and the carbonaceous matter 43 per cent. This effluent has been tried upon various filter beds, with varying results. The first of these beds contained 5 feet depth of sand having an effective size of 0.26 mm., and was operated for 7 months at a rate of 100,000 gallons per acre daily and for the remaining 5 months at double this rate. The results were not altogether satisfactory, the effluent being always somewhat turbid, and having a disagreeable odor, while with sewage in a less advanced state of putrefaction this bed would have given a clear, odorless effluent. The reason advanced for this is that the gases generated in the septic tank, and yet remaining dissolved in the sewage, were inimical to the life of the oxidizing bacteria and prevented them from performing their usual effective work in the filter.

The second experience was with a bed containing pieces of coke of sizes between ⅛ and ¼ inch. The outlet of this bed was closed and the sewage allowed to flow in until the surface was just covered, this requiring about 8 hours. A further period of 2 hours was allowed to elapse and the outlet then opened and the filter allowed to drain slowly. Although this bed was operated at the high rate of 800,000 gallons per acre daily, it gave much better results than the first bed, the effluent coming off clear and odorless, the action being much better than in similar beds with fresher sewage. A third trial was made with a bed similar to the first, but containing finer sand, but although the results were better than in the first case, they were not so satisfactory as those with the coke.

Some subsequent experiments with filter beds of different kinds are discussed in the paper, but the main feature of all the investigations is the demonstration of the importance of providing a filtering material sufficiently coarse to permit the sewage to enter promptly into the layers and there be retained long enough to permit the bacterial action to take place; while the surface of the particles should be rough enough to hold the air as much as possible. An aeration of the sewage was also found to improve the action materially, doubtless by permitting the escape of the gases inimical to bacterial life and also by aiding the contact with oxygen.

The whole conclusion of the paper is that with properly prepared filter beds and a septic tank of moderate size, there is no difficulty in so purifying foul sewage as to produce a clear, odorless effluent at a rapid rate. In the light of these valuable experiences the introduction of proper purification plants should be greatly facilitated and extended.

The Level of the Great Lakes.

THE proposition to raise and control the level of the water in the Great Lakes, which is now being seriously discussed, is one of such importance as to warrant careful examination, especially as it has the approval of the Government Board of Engineers of Deep Waterways. From an abstract of the preliminary report of the Board, given in a recent issue of *Engineering News*, together with an editorial discussion in the same issue, it appears that the project is altogether feasible, that it can be accomplished at a moderate cost, and that the immediate benefits can be directly valued at many times the cost of the work.

Briefly, the proposition is to construct a regulating dam on the Niagara river not far from Buffalo. The regulating feature will be accomplished by making a fixed weir with movable sluices, so that the outflow of Lake Erie may be controlled at all times, and according to the report it will be feasible in this manner to maintain the level in Lake Erie about 3 feet higher than

the usual stage of water during the low-water period in the latter part of the season of navigation. Since the aggregate cost of improving Lake Erie harbors has averaged about $1,000,000 for each foot of permanent depth secured it appears that the value of this raise in level would be $3,000,000, while the cost of the improvement works is estimated at but $800,000.

The extent to which it is proposed to raise the level will in no case cause damage, nor involve expensive changes, since the practical effect will be to maintain constant mean high water in Lake Erie, which will make a corresponding increase in low water depth in Lake St. Clair of 2 feet, and in Lake Huron and Lake Michigan of 1 foot. Lake Superior is beyond the range of effect, but as the waters of this lake reach their high stage in September the maximum discharge into Lake Huron is produced just at the time when that lake is being lowered most rapidly by evaporation and outflow.

One of the especial advantages to be gained by the raising of the lake levels is in connection with the work on the Detroit river. At present there is less than 18 feet depth over the shoals at low water and the necessity of deepening works has been demonstrated if the increasing commerce is to be handled. The increase of 2 feet in depth, which the works at the outlet of Lake Erie would produce, is estimated to save more than enough excavation to pay for the construction of the regulating works.

It must be remembered, however, that there are other questions to be considered besides the mere cost of the actual regulating weir, and its accompanying breakwaters and locks. Any restraint set upon the normal condition of flow in such an extensive system of waterways will affect to some extent the regimen of the immediate waters which supply them and which they feed. Whether any disturbance of vested right may thus be caused remains to be seen, but it is evidently important that such contingencies demand a thorough and discriminating examination of all the possibilities in the problem.

It is noted that the measurements of the flow of the Niagara river, made both by the Board's engineers and by United States engineers, show that there has been a continuous decrease in the discharge. The measurements made in 1869 gave a discharge of 265,000 cubic feet per second, those made in 1890-91 gave but 230,000 cubic feet, while the present measurements show but 220,000 cubic feet, and comparisons reveal a similar decrease in the discharge of the St. Clair and St. Lawrence rivers. The cause of this steady diminution of flow has not yet been made clear.

It is, of course understood that any construction affecting the level of the Great Lakes necessarily becomes a matter for international agreement, and nothing can be done until a proper arrangement has been made between the governments of the United States and Canada, but there is no reason to expect any opposition from Canada in a matter in which she has everything to gain and nothing to lose, as it is proposed to conduct the work entirely at the expense of the United States government.

Power Developments at Niagara.

SINCE the original starting of the great plant of the Niagara Power Company numerous additions have been made to the plant, these including improvements in minor details and extensive additions to the establishments supplied by it. From a very full account by Mr. J. E. Woodbridge in the *American Electrician* some account of the additions is taken, reference to this important paper being necessary for those who desire fuller information than is here available. The original plant was started with three turbines of 5,000 h.p. each, although the tunnel which forms the tail-race of the wheels was constructed for a much larger capacity. During the past two years the generating plant has been increased by the addition of seven 5,000 h.p. machines to the original three. Several new local electro-chemical loads have been added at Niagara Falls, the greatest of which is the new works of the Union Carbide Company, which already absorb 15,000 h.p., or an amount equal to the entire original capacity of the Niagara plant. The long-distance transmission of power has been greatly amplified; 3,000 h.p. being used by the Buffalo General Electric Company, 27 miles away, this being transformed to four different styles

of current for central station service, and all its steam stations being discontinued.

It was originally intended to increase the plant by adding units of 5,000 h.p. until 16 such units had been started, but it is now probable that the present plant of 50,000 h.p. will remain unchanged for some time, and that the privileges on the Canadian side will be developed.

The five units which were added in 1898 were discussed in these columns at that time, and these have been found to embody so fully all the necessary improvements that no further changes have been made in the two latest units. Mr. Woodbridge's paper gives a full section of one of the 5,000 h.p. generators, showing very clearly the changes over the first form. The principal improvements are the method of supporting the bearings in accurate concentric alignment with the frame, and the arrangements for cooling. The centering of the bearings is effected by the use of tapered seats, into which the spiders holding the bearings proper are forced downward by means of bolts. The bearings are piped for an oil-circulating system, while cored chambers in the body of the bearings are piped for a water-circulation. Circulating passages for water are also cored in the ribs of the frame to which the armature laminations are dovetailed, so that the heat can be carried off, and this, together with the air circulation, are found to carry away much of the heat which was such a noticeable feature of the earlier generators. The necessity for providing for the removal of so much heat does not indicate that the generators are not of high efficiency; as a matter of fact the efficiency attained is 98 per cent., but with a plant of this size the 2 per cent. to be dissipated amounts to 100 h.p., and being concentrated into a comparatively limited area it is necessary to provide carefully for its removal.

As an example of the manner in which the work is divided, at a time when eight of the ten generators were in operation, it appears that two machines were run in one battery for the operation of the long-distance transmission loads of Tonawanda, Buffalo, and Lockport, one battery of three generators was running on the load of 15,000 h.p. absorbed by the Union Carbide Company, and the remainder was occupied with the miscellaneous customers, including the various electro-chemical and metallurgical works in the vicinity.

Mr. Woodbridge gives much space to a description of the apparatus installed for delivering 15,000 h.p. to the Carbide Company, this involving transformers with an aggregate capacity of 50,000 h.p. This was found necessary because of the desirability of stepping-up the voltage at the power-house instead of transmitting at the generator pressure of 2,200 volts.

In referring to the transmission line to Buffalo, the most important change which has been made is that of separating the six cables to a greater distance from each other. With the original spacing of 18 inches it was found altogether too easy for mischievously inclined persons to throw pieces of wire, or other metallic substances over the wires, starting arcs and making much trouble at the terminal stations. By introducing lower cross arms a triangular spacing has been arranged, giving a minimum distance of 36 inches between the wires and rendering such malicious mischief much less practicable. The pressure on the line at present is 11,000 volts, but to provide for further increase of loads in Buffalo it is proposed to raise this to 22,000 volts, providing suitable transformers at each end.

Mr. Woodbridge describes in much detail the precautions which have been taken to prevent any interruption to the supply on this long-distance system, and the whole paper is a remarkably complete account of what is at the present time undoubtedly the greatest electrical plant in the world.

American Bridge Builders in Africa.

AN interesting sequel to the much-discussed Atbara Bridge affair is found in the presentation of a paper upon the subject of the bridge before the Engineers' Club of Philadelphia, the paper being by Mr. Richard Khuen, Jr., and the discussion including remarks by some of those who superintended construction of the bridge in the works and those who erected it in its place.

Mr. Khuen emphasizes the point that the bridge itself is a comparatively insignificant structure, being a narrow gauge affair of seven spans of 147 feet each, the

entire contract representing only 750 tons of material, and its construction would hardly have merited more than a brief notice had it not been for the circumstances which attended the placing of a British government contract with an American firm, both on account of lower price and much shorter time than any British firm would offer.

The paper gives a detailed description of the bridge, similar to the various accounts already published, both in England and America, and furnishes complete detailed drawings and strain sheets, giving the plans and computations which were made for this especial structure, showing conclusively that the whole bridge was designed and constructed subsequently to the receipt of the order, and effectually disposing of the idea that any portion of it was in stock at that time.

The contract undertook to deliver the completed bridge to the vessel in New York in 42 days, the actual time was 40 days, and the time occupied in the construction was 29 working days, making deduction for seven days lost during the great snow storm when the works was closed, and the four Sundays on which no work was done. While this may seem rapid work, Mr. Khuen calls attention to the fact that the capacity of the Pencoyd Works is from 5,000 to 6,000 net tons per month, so that this little contract of 750 tons practically represents only about four days' work for the entire shop.

Apart from the general English criticisms of the design because of its pin connections, the author calls attention to the fact that criticisms in *Engineering* and in *Stahl und Eisen* are based on typographical errors in the published descriptions of the bridge, and even these are unimportant.

"A partial explanation of the difference between the time the British manufacturers specified in their bids for this comparatively small contract and that specified by the Pencoyd Iron Works and other American bidders lies in the standardizing of structural shapes and in the improved machinery in use in the United States. Another explanation lies in the fact that an American bridge designer studies all designs with a view to duplication of parts to reduce templet work, and tries to make the shop work as uniform as possible and in accordance with an established standard. He also confines himself to standard shapes, and can therefore rely on receiving his material at once.

"A British designer prides himself on his originality, and attempts to stamp his individuality on his work; consequently there is no uniformity in shop work. He also uses special shapes, for the same reason, so that new rolls usually have to be made for nearly every contract, entailing considerable loss of time with no compensation in the form of improved work. This applies equally as well to locomotives and other engineering products. The conservative policy of British manufacturers as regards machinery is well known, while American manufacturers are continually discarding the old methods and machinery for more modern."

Some interesting remarks were made by Messrs. Wennas and Wolfel, of the party who went out to the Soudan to assist in the erection of the bridge, the difficulties with Egyptian and Soudanese workmen being told; and it may be of interest to learn that the method of erection, about which there has been some discussion, was planned especially for this case, not having been employed anywhere before so far as the constructors knew, but being derived from the exigencies of the situation.

The American Iron Trade.

THE remarkable developments of the iron trade during the year 1899 render the review of the business in the Pittsburg district, by Mr. Robert A. Walker, in the *Iron Age*, a matter of especial interest at the present time. The year has been the greatest ever known in the iron trade, both in the volume of business and in its profits, and for activity, advances in prices, and records in every department it will probably stand without a parallel for many years to come.

The whole year has been one continuous record of advancing prices, increasing demand, and great profits; and there is every prospect that the present year will show a maintenance of the demand thus created.

As an example of the advance which has been experienced in 1899, we may quote

what Mr. Walker says about the advance in pig iron:

"The blast-furnace that cannot show a balance on the right side of the ledger at the close of this year nearly as large as the investment itself, or perhaps larger, has certainly something wrong with its management, or there is something out of order somewhere."

In January, 1899, Bessemer pig iron was selling at $10 to $10.25. By the close of the year the price had risen to $24 per ton! This remarkable advance came gradually and steadily throughout the year, and was by no means speculative, but was caused by the increasing demand for legitimate purposes.

Turning now to the production of steel rails, the tonnage was enormous, the output of the leading mills having been unparalleled. At the beginning of the year the price was about $17 per ton. By the close of 1899, the price had advanced to $35 to $37 per ton at mill. The output of the rail mills for 1899 will certainly be found to have been considerably more than 2,000,000 tons, and the average of prices will undoubtedly show a very handsome profit. The profitable business which has been done by the railroads has put them in the market as purchasers for material for 1900 delivery, and so, notwithstanding the high prices the purchases will doubtless continue to be extensive. A similar heavy demand appeared early in the year for structural material, and during the middle of the year there was a famine in material for three or four months, fabulous prices being paid where sellers were able to promise anything like prompt delivery.

The heaviest advance, however, appeared in plates, the price for tank plates have risen from 1.25 cents in January, 1899, to 3 cents, in July, an advance of $35 a ton. For four or five months in the middle of the year material could hardly be had at any price, and work was delayed all over the country on account of the inability of contractors to get shipments from the mills. In spite of enormous increase in capacity, due to the building of new mills by some companies and enlargements by others, it was not until October that the mills began to catch up with their orders. Much of this demand for plates has been caused by the large consumption of the Pressed Steel Car Company, which is using from 1,000 to 1,500 tons per day in the manufacture of steel cars; the greater portion of this tonnage being furnished on a ten-year agreement by the Carnegie Steel Company.

Taking a general view of this phenomenal rise, and considering that it was undoubtedly due to a legitimate demand for actual consumption, it becomes possible to predict, with a fair degree of accuracy, the prospects for the year 1900. There is little fear that the rise in prices will lessen the demand for iron and steel finished products. The prices have not risen sufficiently to cause this to be the case, and when the amount of work which has been postponed is considered, it will be seen that there is ample demand to insure a constant market during the present year. There is a vast amount of work which must be done, and the material for it must be got somehow, and under such circumstances the market will surely be sustained.

All this takes into account only the home market, but there is a foreign market to be considered. During the past year America made 40 per cent. of the world's iron. This proportion is on the increase, and will doubtless continue so, in view of the great natural resources of the country, because of its superior plant, and because of its active and intelligent labor. In the one item of electric tramways alone, the development in Europe is scarcely begun, and the demand for rails, trolley poles and material must be largely supplied from America.

The Regulation of Gas Engines.

A FEATURE in the modern internal combustion motor, which is sometimes made what is called a "talking point," is that of the method of regulation of speed, and a communication from Mr. W. H. Booth in a recent issue of the *American Machinist* brings out some interesting features of this detail.

The methods of governing may be broadly divided into two classes, one being the "hit-and-miss" method, and the other the method of regulated charges. The hit-and-miss plan originated with the old Otto and Langen explosion engine, in which the action took place by exploding a charge of

gas and air under a free piston, which was thus shot up into the air, and then drawn down by the action of the vacuum formed in the cylinder. Obviously there was no other method of governing such an engine, and it was rather curious to observe the intermittent manner in which this free piston would shoot up at all sorts of irregular intervals, as the variations in the load demanded. The so-called Otto "silent" engine, which was the immediate successor of the Otto and Langen, being made by the same builders, was naturally provided with the same method of governing, and thus, by a sort of mechanical heredity, the hit-and-miss method came into very general use.

Various detailed methods have been devised to carry out this plan of governing, some engines being fitted with centrifugal governors which throw the valve gear in or out of action as the speed falls or rises, while others are provided with a pendulum gear having a rate of vibration dependent upon its length and permitting the valve gear to operate only when the reciprocations of the engine fall below the rate of vibration of the pendulum.

Of the superior economy of this method of governing there is no doubt. When the speed is maintained no consumption of gas takes place whatever, and when the speed falls only so much gas is used as is absolutely necessary to restore the rate. With such an expensive fuel as illuminating gas this economy was practically essential, and even under such circumstance the gas engine only came into use extensively for such work as demanded intermittent loads and in which the advantages of convenience were of more importance than actual economy of fuel.

The method of regulating the mixture of air and gas in the charge has undoubted advantages, so far as superiority of regulation is concerned, and with the present requirements of such motors, especially for driving electric generators, this is a matter of much importance. It is evident that the motion of an engine which makes only one power stroke in every four cannot be as uniform as that of a steam engine, and when to this lack of uniform impulse is added the omission of power-strokes as a means of checking speed it is apparent that noticeable fluctuations must occur.

Mr. Booth points out very clearly that at the present time the question of gas-engine economy stands on a different basis from that existing when it was first introduced on the market, and that the use of cheap producer-gas or of the waste gases of blast furnaces renders it no longer necessary to measure out the number of charges with that careful economy obtaining when such a choice commodity as illuminating gas is the fuel.

"Producer gas is so cheap that it has enabled gas engines to be more employed, and the cost of power thus produced has been found to be so small that the advantage of the hit-and-miss method of governing has lost its chief point of advantage, for the money cost of the more regular control of regulated charges is so very small as to afford the advantages of regular rotation."

Mr. Booth takes occasion again to emphasize the great waste of power which is permitted by the non-utilization of blast-furnace gases.

"It is surprising to see how very slowly people wake up to the idea of using blast-furnace gas, which is so cheap and plentiful that if anyone undertakes to use the output of a single furnace he will need to put down about the biggest installation of gas engines yet going.

"In California they will spend thousands of dollars in building headworks, dams, tunnels, and pipe-lines to utilize distant water-powers, whereas the cost of utilizing waste gas is very much less. It is almost as if everything in a water-power scheme were to be given free except the turbines. There is very little doubt that in a few years we shall see a large amount of electricity generated by gas power from gases now practically wasted."

This question of the character of the gas used upon the method of governing to be employed is a point well made, and the time is doubtless at hand when the design of a gas motor will be made to depend largely upon the character of the fuel with which it is to be worked.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Bridges. *m.* Chicago.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago, U. S. A.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Ceilings.

Ceilings. L. A. Shuffrey. Resumé of a paper read before the Liverpool Arch't Soc. Reviews the progress, illustrating famous ceilings in England from the time of Henry VIII. 2500 w. Builder—Dec. 16, 1899. No. 31610 A.

Steel Furring for Ornamental Ceilings. Illustrates and describes the methods employed to produce the effect of gothic masonry ceilings by light concrete-steel construction. 800 w. Eng Rec—Dec. 23, 1899. No. 31481.

Exposition.

The U. S. Machinery Building at the Paris Exposition. Illustrated description of the building designed to furnish a true idea of an American shop. 1100 w. Eng Rec—Dec. 16, 1899. No. 31471.

Foundations.

Foundations of Buildings. S. Anglin. Read before the Manchester, Eng., Soc. of Archts. On the superstructure or foundations of buildings in general, and of steel skeleton construction in particular. 4200 w. Jour Roy Inst of Brit Archts—Nov. 11, 1899. No. 31321 D.

The Foundations of a Large Power House. Describes the methods of putting in a thick spread concrete base under the 70,000 H. P. station of the 3d Ave. Ry. Co., New York. 1200 w. Eng Rec—Dec. 16, 1899. No. 31473.

Mural Painting.

Mural Painting in Its Relation to Architecture. Elmer E. Garnsey. Read before the Am. Inst. of Architects. On the value and treatment of color. 4000 w. Am Arch't—Dec. 2, 1899. No. 31183.

Roof.

The Forty-Seventh Regiment Armory Roof, Brooklyn. Illustrated description of the design and erection of a steel roof framework with a transverse span of nearly 200 ft. and a rise of 84 ft. 1200 w. Eng Rec—Dec. 23, 1899. No. 31483.

Skeleton Structures.

The Legitimate Design of the Architectural Casing for Steel Skeleton Structures. C. H. Blackall. Read before the Am. Inst. of Archts. Considers the designs most generally accepted and discusses some absurdities. 2800 w. Am Archt—Dec. 2, 1899. No. 31184.

HEATING AND VENTILATION.

Hot Water.

Overhead Hot Water Heating System in Masonic Temple Building. Illustrated description of the system adopted at this large building in Staunton, Va. 1200 w. Met Work—Dec. 16, 1899. No. 31392.

The Calculations for Pipes for Hot Water Heating (Berechnung von Rohrleitungen für Warmwasserheizungen). H. Weiprecht. Deriving a formula for use in practice, and giving examples of computations. 1800 w. Gesundheits-Ingenieur—Nov. 30, 1899. No. 31584 B.

Residence.

Ventilation and Heating of a Large New York Residence. Illustrated description of the plant in the W. D. Sloane mansion, which includes both indirect heating and a modified hot-blast system. 3300 w. Eng Rec—Dec. 23, 1899. No. 31484.

Steam Heating.

A Low-Pressure Gravity Heating Apparatus in a School House. Illustrated description of a one-pipe steam heating system with gravity return, in a Milwaukee high school. 1800 w. Eng Rec—Dec. 16, 1899. No. 31472.

Good and Bad Practice in Steam Heating. W. H. Wakeman. Discusses some points in the heating with exhaust steam. 900 w. Am Mach—Dec. 21, 1899. No. 31432.

PLUMBING AND GAS FITTING.

Sanitation.

Plumbing and Household Sanitation. J. Pickering Putnam. On the importance and the architect's responsibility, the neglect, and sources of danger. Ill. 7000 w. Dom Engng—Dec., 1899. No. 31-624 C.

MISCELLANY.

Address.

Presidential Address before the Royal Institute of British Architects. William Emerson. Historical review of progress during the past century. Also discussion. 9500 w. Jour Roy Inst of Brit Archts—Nov. 11, 1899. No. 31320 D.

Building Stones.

Building Stones and Stone Cutting. Alexander Marshall. Read before the Toronto Chapter Ontario Assn. of Archts. Gives information relating to the strength and durability of various stones, and the care needed in cutting. 2700 w. Can Archt—Dec., 1899. No. 31-486 C.

Exposition.

The Palaces of Foreign Nations at the Paris Exposition. Illustrations of a number of these buildings. 900 w. Ir Age—Dec. 7, 1899. No. 31264.

Fireproofing.

See Civil Engineering, Miscellany.

Metal.

Expanded Metal. J. P. Allen. Read at meeting of the Northern Arch't Assn., England. Describes this material, and discusses its uses to the building trades. 5500 w. Archt, Lond—Dec. 16, 1899. No. 31611 A.

CIVIL ENGINEERING

BRIDGES.

Arches.

The Three-Hinged Arch. Considers the origin of hinged arches, and the applications to which the three-hinged arch is adapted, with other information. 2000 w. Engr, Lond—Dec. 1, 1899. No. 31344 A.

Bridges and Tunnels.

Proposed Plans for Bridges and Tunnels Across the East River at New York City. Discusses the plans for improving the transit facilities. Also editorial discussion. 3000 w. Eng News—Dec. 28, 1899. No. 31644.

The Relative Advantages of Bridges and Tunnels. Discusses the advisability of driving tunnels for communication between two large communities for which long-span bridges offer the only alternative connection. Also report on the use of tunnels between Brooklyn and Manhattan, New York, by W. B. Parsons. 2800 w. Eng Rec—Dec. 16, 1899. No. 31465.

Design.

The Artistic Side of Bridge Design. A reply to an editorial in the *N. Y. Times*, condemning the American engineer for his lack of artistic feeling. Ill. 900 w. Eng News—Dec. 21, 1899. No. 31462.

Drawbridges.

An Electric Drawbridge at Boston. W. S. Key. Illustrated description of a new bridge across the Charles River, the draw being operated by means of two G. E. "58" railway motors of 28 h. p. capacity each. 1600 w. Elec Wld & Engr—Dec. 23, 1899. No. 31602.

Experimental Determination of Draw-Bridge Reactions. Malverd A. Howe. An account of investigations made to determine a reliable method for computing these reactions. 2000 w. Eng News—Nov. 30, 1899. No. 31155.

East River.

The New East River Bridge. Extracts from the address of O. F. Nichols before the Broadway Merchants' Association of Brooklyn. Ill. 1800 w. R R Gaz—Dec. 15, 1899. No. 31373.

Highway Bridge.

Highway Bridge at Nogent-sur-Marne (Pont Route de Nogent-sur-Marne). A. Dumas. Illustrated description of a handsome cast-iron arch bridge across the Marne, with details of the piers and abutments. 2500 w. 1 plate. Génie Civil—Dec. 9, 1899. No. 31506 D.

Japan.

American Bridges in Japan. Illustrated description of two bridges containing a number of special features made necessary by the requirements of the transportation facilities. 1000 w. Eng Rec—Dec. 23, 1899. No. 31479.

Joints.

Flexible Joints (Joints Flexibles). A discussion of the methods of M. Mesnager for providing flexibility in members of trussed structures in order to avoid non-axial stresses. 1500 w. Revue Technique—Dec. 10, 1899. No. 31517 D.

Piers.

The New Cornwall Bridge Piers. Illustrated description of the difficult work of tearing down and rebuilding large concrete and limestone piers which were originally founded on unstable bottom. 5000 w. Eng Rec—Dec. 9, 1899. No. 31301.

Suspension.

Comparison of Suspension Cable Specifications of Brooklyn and New East River Bridges. Editorial comparison of the leading features of the two structures. 2200 w. Eng News—Nov. 30, 1899. No. 31157.

Temporary Work.

The Temporary Restoration of Railway Bridges. An account, with illustrations, of the type of structure and methods of operation for rapid construction. Part first considers wooden bridges. 3200 w. Engng—Nov. 24, 1899. Serial. 1st part. No. 31205 A.

Tunis.

Trolley Bridge at Bizerta, Tunis. Il-

lustrates and describes what is known in France as the "transbordeur" type of bridge of the Arnodin's system. 1500 w. Ry & Engng Rev—Dec. 2, 1899. No. 31200.

Viaducts.

Viaduct Alterations Without the Use of Falsework. F. S. Edinger. Reported at the meeting of the Assn. of Ry. Supts. of Bridges and Buildings. Describes repairs without falsework to a structure 117 ft. high and 440 ft. long, without delay of trains. 1400 w. Ry & Engng Rev —Dec. 9, 1899. No. 31311.

CONSTRUCTION.

Caissons.

Caisson for the Intake Pier for the Cincinnati Water-Works. Illustrated description of the 58 x 30 ft. caisson for a heavy masonry pier considerably over 100 ft. high. 500 w. Eng Rec—Dec. 9, 1899. No. 31300.

Colombo.

Old and New Colombo. John Ferguson. Gives the history, industries, minerals, gems, etc.; describes the railways, harbor works, sanitation, and other matters of interest in this capital city of Ceylon. Discussion. 16500 w. Jour Soc of Arts—Dec. 15, 1899. No. 31499 A.

Concrete Docks.

Concrete Docks for the Illinois Steel Co., at South Chicago, Illinois. Describes the conditions which made necessary reconstruction, and gives an illustrated description of the type adopted. 1700 w. Eng News—Dec. 14, 1899. No. 31365.

Concrete Docks of the South Works of the Illinois Steel Company. Illustrations showing the details of construction, with brief description. 1200 w. Ir Age —Dec. 14, 1899. No. 31341.

Cribs.

Cost of Crib Construction—Brief Methods for Preparing Estimates. G. A. M. Liljencrantz. Explains the plan of the writer for obtaining a reasonably accurate estimate in a short time. Describes four different methods, each in turn giving a closer approximation to accuracy than the preceding. 4000 w. Jour W. Soc of Engs—Oct., 1899. No. 31-303 D.

Dikes.

The Construction of Earthen Dikes (Construction des Digues en Terre). A. Dumas. A description of the so-called English method, in which a central puddle-wall of clay is used to insure resistance to leakage. 2000 w. Génie Civil —Dec. 2, 1899. No. 31505 D.

Dredges.

Steam Tenders and Dredges on the Mississippi River. Illustrated description of one of the five large tenders under construction. 1500 w. Eng News—Dec. 7, 1899. No. 31289.

Excavator.

Lowrie's Power Excavator. Illustrated description of a new design containing novel features. 1300 w. R R Gaz—Dec. 8, 1899. No. 31293.

Foundations.

See Architectural Engineering, Construction.

Simplon Tunnel.

A New Tunnel Over the Alps. Information relating to the progress of work on this railway tunnel. 800 w. Loc Engng—Dec., 1899. No. 31144 C.

HYDRAULIC AND MARINE.

Aqueduct.

Completing the Abandoned Aqueduct Tunnel at Washington, D. C. Gives a brief statement of the original work on this tunnel, which was abandoned ten years ago, and an illustrated description of the methods employed to complete the work. 18000 w. Eng News—Dec. 28, 1899. No. 31641.

Canals.

Internal Navigation in France in 1898 (La Navigation Intérieure de la France en 1898). A discussion of the official figures, which show an increase of 4.8 per cent. in ton-kilometres over the preceding year. 1000 w. Moniteur Industriel—Nov. 25, 1899. No. 31569 F.

Report of the Special Commission on the Chicago Drainage Canal. An abstract of the report of the special commission appointed to see if the work was executed in accordance with the law, and of the reply of the Trustees who dispute some points. 4500 w. Eng News—Dec. 7, 1899. No. 31286.

The Effects of the Manchester Ship Canal. Abstract of paper by A. Woodroofe Fletcher. Credits the canal with causing the great revival in trade and general prosperity. 2500 w. Engr, Lond —Dec. 8, 1899. No. 31421 A.

The Rhine-Elbe Canal and the Railways of the Ruhr District (Der Rhein-Elbe-Kanal und die Eisenbahen des Ruhrbezirks). A discussion of the question of the capacity of the railways to handle the traffic of the district, and of the necessity for the proposed canal. 4000 w. Glückauf—Nov. 18, 1899. No. 31-540 B.

Dams.

Earth Backing for Masonry Dams. E. S. Gould. A theoretical demonstration

that an earth-fill behind a masonry dam diminishes the pressure coming on it. 1000 w. Eng Rec—Dec. 23, 1899. No. 31482.

Distribution.

Some Notes on the Design of Water-Works Distribution Systems. Gardner S. Williams. Considers the essentials of this question. Also discussion. 7500 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31378 E.

Drainage.

Hints on Farm Drainage. The Proper Methods and Results of Draining Land. Anton Vogt. Discusses tile drainage and results, with suggestions for laying the tile, etc. 5000 w. Brick—Dec. 1, 1899. Serial. 1st part. No. 31270.

The Drainage of Poona. A statement of the existing conditions, and the need of promptly rectifying the sanitary defects. 2500 w. Ind & East Engr—Nov., 1899. No. 31387 D.

Flood-Water.

Flood-Water Channel of the Altoona, Pa., Reservoirs. Charles W. Knight. Illustrated detailed description of a channel built to keep out acccumulations brought down the valleys by the floods. 2000 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31382 E.

Flow.

Pini's Apparatus for Measuring the Velocity of Flowing Water (Ueber Sante Pini's Apparate für Geschwindigkeits messungen in Fliessenden Wasser). V. Pollack. Describing a modification of the Pitot tube which gives good results in measuring the velocity of currents. Two articles, 9000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 17, 24, 1899. No. 31-526 each B.

The Flow of Water in Pipes. C. H. Tutton. An attempt to show that the Torricellian formula, $v^2 = 2gh$, is misapplied in the fundamental stages of the science of hydraulics. 13 plates. 5700 w. Jour Assn of Engng Socs—Oct., 1899. No. 31125 C.

The Measurement of the Velocity of Flow of Streams (Ueber Messungen der Bewegungs-Geschwindigkeiten von Flussläufen). Paul Fuchs. A description of the Schultze apparatus by which information as to the flow and level of streams can be electrically communicated to a distance. 2500 w. Gesundheits-Ingenieur—Nov. 30, 1899. No. 31583 B.

Ground Water.

Principles and Conditions of the Movements of Ground Water. Extract from 19th Annual Report of the U. S. Geol. Surv. Investigations made by F. H. King and C. S. Slichter. 2800 w. Eng News—Dec. 28, 1899. No. 31646.

The Law Relating to Underground Water. Lecture by Robert Cecil. Explains the historical development of the English law relating to percolating water. 6000 w. Jour Gas Lgt—Nov. 7, 1899. No. 31164 A.

Harbor Works.

Notes from Japan. Gives illustrations and descriptions of the Otaru harbor works. 2800 w. Engng—Dec. 15, 1899. No. 31617 A.

Hydrants.

The Care of Fire Hydrants in Winter. George I. Bailey. Considers methods for their care and maintenance. 2000 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31379 E.

Level Indicator.

Long-Distance Water-Level Indicator (Wasserstands-Fernmelde-Apparat). A description of the Siedek-Schäffler apparatus, by which the level of any body of water may be ascertained at a distant station. The indications of a float-device are electrically transmitted. 6000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1899. No. 31531 D.

Light-houses.

Lighthouse Engineering at Home and Abroad. J. A. Purves. Abstract of a paper read before the Inst. of Engs. and Shipbuilders in Scotland. An illustrated historical review. 6000 w. Engs' Gaz—Dec., 1899. No 31327 A.

Pipe Coatings.

Coatings for Cast-Iron Water-Pipes. Thomas H. Wiggin. Extract from a paper on "The Manufacture and Inspection of Cast-Iron Pipes," read before the Boston Society of Civil Engineers. Gives the results of the writer's study and experiments. 6200 w. Jour Am Soc of Nav Engs—Nov., 1899. No. 31236 H.

Pumping Engines.

See Mechanical Engineering, Hydraulic.

Reservoirs.

A Concrete-Asphalt Reservoir Lining. Describes the lining of a basin having a capacity of 15,600,000 gallons, at Whitby, Eng., with two layers of concrete with asphalted canvas between them. 1600 w. Eng Rec—Dec. 16, 1899. No. 31470.

River Discharge.

Discharge Measurement of the Niagara River, at Buffalo, N. Y. An outline of the work performed, with some general conclusions. 900 w. Eng News—Dec. 28, 1899. No. 31643.

River Improvement.

The Regulation of the Wottawa at Strakonitz, Bohemia (Die Regulierung

der Wottawa bei Strakonitz). F. Stupecky. A report upon the regulation of a feeder of the Moldau, showing how the flooding of the surrounding country was prevented by providing a permanent channel. 5000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1899. No. 31530 D.

Standpipes.

Standpipes. Byron I. Cook. Describes the construction of several. Also discussion. 3500 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31380 E.

Water Filters.

Ice Elevator at the Lawrence Filter Beds. Illustrated description of the elevating machine, something like a ladder dredge, used to take the ice from the open sand filters. 500 w. Eng Rec—Dec. 9, 1899. No. 31302.

The Regulation of the Albany Filters. An explanation of the methods adopted at this plant to combine the advantages of both the British and German methods of operating slow-sand filters. 900 w. Eng Rec—Dec. 9, 1899. No. 31299.

Water Meters.

A Meter-Testing Apparatus. Emil L. Nuebling. Illustrates and describes the plant of the Reading, Pa., Water Dept. 700 w. Eng Rec—Dec. 23, 1899. No. 31477.

Water Rates.

Methods of Assessment and Collection of Water Rates. F. H. Crandall. Discusses various methods. General discussion. 9500 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31381 E.

Water Supply.

The Water-Works of Media, Pa. Illustrated description of a plant containing a number of novel features for the regulation of the supply for high and low service districts, with the results of a test of the pumping plant. 1800 w. Eng Rec—Dec. 2, 1899. No. 31192.

Water Supply and Purification Works at Parkville and Bethany, Mo. Wynkoop Kiersted. Illustrates and describes the sedimentation and mechanical filtration plant at Parkville, Mo., and the new intake crib, siphon, filter bed and clean water well at Bethany, Mo. 1600 w. Eng News—Dec. 14, 1899. No. 31-368.

MATERIALS.

Beams.

Compound Beams (Zusammengesetzte Träger). A. Schneider. A mathematical discussion of the strength of built-up timber beams, with tables for various loadings and examinations of special cases. Three articles, 12000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 24, Dec. 1, 9, 1899. No. 31527 each B.

Bricks.

Brick Testing in 1895-1897 (Ziegelprüfungen in den Betriebsjahren 1895-1897). M. Gary. A very full review and record of the tests made at the Royal Testing Laboratory at Charlottenburg, with tabulated details and curves of results. 15000 w. Mitt aus den Kgl Tech Versuchsanstalt—Part IV., 1899. No. 31578 G.

The Resistance of Brick Masonry (Die Tragfahigkeit von Ziegel-Mauerwerk). F. von Emperger. A review of recent English and American experiments, with illustrations of many tests. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 1, 1899. No. 31528 B.

Cement.

Cement Tests for Municipal Works. Discusses the advantages of testing cement for different cities in a state laboratory. 1400 w. Eng Rec—Dec. 16, 1899. No. 31466.

Economies of Cement Mortar. Ira O. Baker. Considers methods of proportioning the mortar, tensile strength, cost, etc. 2200 w. Br Build—Dec., 1899. No. 31623 C.

The Works of the Nazareth Portland Cement Company. Illustrated description of a 1000-bbl. plant containing considerable special machinery, including a new type of rotary dryer using powdered coal as fuel. 2000 w. Eng Rec—Dec. 16, 1899. No. 31467.

Concrete.

A Complete Mixer Plant. Illustrated description of the plant used to mix concrete for gun emplacements at a place where labor was difficult to obtain and the machinery had to be as nearly automatic as possible. 1400 w. Eng Rec—Dec. 2, 1899. No. 31193.

The Theory and Practice of Concrete. Discussion of the features of concrete making which are still matters of dispute. 1200 w. Eng Rec—Dec. 23, 1899. No. 31474.

Fireproofing.

A Wood Fireproofing Plant. Illustrated description of a plant for injecting a fireproofing liquid into wood, with a statement of the results of the process. 1700 w. Eng Rec—Dec. 2, 1899. No. 31194.

Fire-Proof Wood for Ships. Illustrates and describes one of the plants and the process of manufacture. 2000 w. Marine Rev—Nov. 30, 1899. No. 31121.

Piles.

Worm Eaten Piles. Onward Bates. A report of investigations made, and of

the writer's experience with southern timber. 1500 w. Jour W Soc of Engs—Oct., 1899. No. 31305 D.

Pillars.

The Resistance of Built-Up Stone Pillars to Buckling (Zur Berechnung der Knickfestigkeit Gegliederter Steinpfeiler). Deriving a general formula for practical use in proportioning stone pillars, and showing the application of the method by examples. 1200 w. Deutsche Bauzeitung—Nov. 25, 1899. No. 31571 B.

Structural Iron.

The Permissible Stresses Upon Structural Iron (Die Zulässigen Inanspruchnahmen des Eisens in Hochbau). F. von Emperger. A mathematical discussion of the relative proportions of beams, columns, girders, etc., in modern building construction. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 2, 1899. No. 31524 D.

Timber.

The Present Status of the Study of Timber (Der Heutige Stand der Holzuntersuchungen). M. Rudeloff. A discussion of the present methods of testing timber, with suggestions as to the international unification of testing methods. 7500 w. Mitt aus den Kgl Tech Versuchsanstalt—Part IV., 1899. No. 31579 G.

MUNICIPAL.

Compensation.

Extra Work of City Surveyors. Reviews a decision of the Wisconsin Supreme Court that the city surveyor of Madison should be paid an extra fee outside his salary for any sewer work he designed. 900 w. Eng Rec—Dec. 2, 1899. No. 31189.

Glasgow.

Cities and Public Works. The Correct Story of Glasgow's Achievements. Robert Watt. Compares the conditions of Glasgow and San Francisco, and favors private control. 2400 w. Am Gas Lgt Jour—Dec. 4, 1899. No. 31185.

Parks.

The Park Systems of Boston and Vicinity. A statement of the radically different plans followed by the city and state commissions. 900 w. Eng Rec—Dec. 2, 1899. No. 31191.

Paving.

Maintenance of Asphalt Streets in Cincinnati, O. Describes particularly the methods of repairing street openings and keeping pavements in repair along tracks. 1000 w. Eng Rec—Dec. 2, 1899. No. 31197.

Notes on Brick Pavements. An account of the practice in Buffalo, Cleveland, Cincinnati, Louisville, Kansas City, Omaha, St. Louis, Detroit, Philadelphia, and Providence. 1700 w. Eng Rec—Dec. 23, 1899. No. 31480.

Street Paving in Michigan. A summary of the work done in 1898, with costs and methods. 1200 w. Eng Rec—Dec. 2, 1899. No. 31195.

Refuse.

The Next Step in the Work of Refuse and Garbage Disposal. W. F. Morse. Read at meeting of the Am. Pub. Health Assn., at Minneapolis. Reviews the progress recently made, and the points where improvements are needed, giving an account of works at Boston and in English cities. 10500 w. San—Dec., 1899. No. 31169 D.

Notes on the Operation of the Montreal Garbage Furnace. Notes on the operation of a furnace built on English lines which claims to burn the garbage with practically no expense for fuel. 1100 w. Eng News—Dec. 7, 1899. No. 31288.

Sewage.

Chemical Precipitation and Rapid Filtration of Sewage at Madison, Wis. Outlines the history of sewage disposal in this city and gives an illustrated description of the new plant in operation since June, with objections raised and alleged defects. 4400 w. Eng News—Dec. 28, 1899. No. 31642.

Diversion and Purification of the Sewage of Paris. An account of this scheme and its practical realization, which marks the progress of sanitary science in France. 2800 w. Engr, Lond—Nov. 24, 1899. No. 31212 A.

Experiments on Sewage Purification at the Lawrence Experiment Station During 1898. From the report of the Massachusetts State Board of Health, outlining the work. 2000 w. Eng News—Dec. 21, 1899. No. 31461.

Manchester Sewage. Editorial on the changes in disposal made necessary by the construction of the ship canal, and the experiments made. 3000 w. Engng—Dec. 1, 1899. No. 31331 A.

Manchester Sewage. Report of investigations made by three experts is outlined and some points discussed. 3000 w. Engr, Lond—Nov. 24, 1899. No. 31213 A.

Recent Lawrence Experiments in Sewage Disposal. A review of the investigations of the Massachusetts Board of Health in 1898, with septic tank and bacteria bed methods of disposal. 3200 w. Eng Rec—Dec. 23, 1899. No. 31476.

Sewage Disposal at Lincoln, England. James H. Fuertes. Illustrated explanation of the works for chemical treatment with ferozone, filtration of the sewage thus dosed through polarite beds, and

the use of the effluent for irrigation. 1100 w. Eng Rec—Dec. 23, 1899. No. 31478.

Sewage Disposal at Manchester, England. James H. Fuertes. Illustrated description of the chemical treatment works in use in 1899, and a brief description of the experiments to find some more satisfactory system. 1400 w. Eng Rec—Dec. 2, 1899. No. 31196.

The Septic Tank at Overbrook, N. J. Describes a small system and gives the results attained in its use. 1200 w. Eng Rec—Dec. 16, 1899. No. 31468.

Sewers.

A Large Overflow Chamber. Illustrated description of an overflow on a sewer 14¾ ft. in diameter, at Cleveland, O. 1200 w. Eng Rec—Dec. 16, 1899. No. 31469.

Streets.

The Financial Loss Caused by Narrow Streets. Reviews some figures recently given by J. W. Barry, of the delay in traffic on four London streets due to congestion. 800 w. Eng Rec—Dec. 2, 1899. No. 31190.

MISCELLANY.

Address.

Presidential Address before the Institution of Civil Engineers. Sir Douglas Fox. Condensed address of more than usual interest, touching upon many branches of engineering. 4700 w. Eng News—Nov. 30, 1899. No. 31158.

Education

Some Unrecognized Functions of Our State Universities. J. R. Johnson. Full address on the occasion of inauguration as Dean of the College of Mechanics and Engineering of the Univ. of Wisconsin. 6000 w. Jour W. Soc of Engs—Oct., 1899. No. 31304 D.

Technical Education in Germany. Extract from address of Jas. Loudon, at the Univ. of Toronto. 1500 w. Eng News—Nov. 30, 1899. No. 31156.

Engineering Work.

The Great Lakes. John Birkinbine. An account of the magnitude and diversity of the engineering work in this region. 5400 w. Jour of Worcester Poly Inst—Nov., 1899. No. 31127 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Fire-Alarm.

A Modern Fire-Alarm System. Illustrated description of the protective equipment of the Washington Life Insurance Building, New York City. 1000 w. Elec Rev, N. Y.—Dec. 20, 1899. No. 31447.

South Africa.

News from South Africa. Explaining how the war news from Natal reaches New York. 700 w. Elec Rev, N. Y.—Nov. 29, 1899. No. 31136.

Space Telegraphy.

A Non-Technical Account of Wireless Telegraphy. Brief review of discoveries made and explanation of the principles. 2000 w. Min & Sci Pr—Dec. 2, 1899. No. 31263.

The Guarini Relay System (Relais Sistema Guarini). A description of the Guarini relay, by means of which the space covered by the Marconi apparatus may be greatly increased. The action of the coherer operates a fresh transmitter. 2500 w. L'Elettricità—Nov. 25, 1899. No. 31566 B.

The Invention of the Coherer. Camillo Olivetti. The object of the article is to show the real inventor to be Dr. Temistocle Calzecchi Onesti. Ill. 1000 w. Elec Wld & Engr—Dec. 2, 1899. No. 31174.

Telegraphs.

Uganda State Railway Telegraphs. Brief description of the materials used and the lines constructed. 2000 w. Elec Rev, Lond—Nov. 24, 1899. No. 31225 A.

The True Inventor of the Telegraph. Heileman Wilson. Claims the inventor was the writer of an article published in The *Scots Magazine*, Glasgow, 1753, signed C. M. 1000 w. Sci Am—Dec. 30, 1899. No. 31625.

The Zerograph. Illustrated description of this improved instrument—an office type-printing telegraph. 1300 w. Elect'n, Lond—Nov. 24, 1899. No. 31226 A.

Telephone Building.

The New Telephone Establishment at Vienna (Die Neue Telephonanlage in Wien). K. B. von Wehrenalp. With interior and exterior views and plans of the new building, showing the completeness of its arrangements. Serial. Part I. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 8, 1899. No. 31529 B.

Telephone Exchange.

Power Plants in Modern Telephone Exchanges. H. P. Clausen. Discusses the requirements of a plant, and the construction. Ill. 2000 w. Elec Engng & Tel Mag—Dec., 1899. No. 31487.

The New Common Battery Bell Telephone Exchange, Brooklyn, N. Y. Illustrated detailed description of the latest

Bell practice, with map showing the distribution of exchanges in Brooklyn. 3200 w. Elec Wld & Engr—Dec. 23, 1899. No. 31600.

Telephones.

Largest Telephone System in the World. On the development of the use of the telephone in the city of New York, and the reduction in rates. 1300 w. Elec Rev, N. Y.—Dec. 27, 1899. No. 31634.

The Copenhagen "Automatic" Telephone Call-Boxes. Illustrated description of telephones on the "penny-in-the-slot" principle. 400 w. Elect'n, Lond—Dec. 1, 1899. No. 31324 A.

Telephone Systems.

The Merits of Independent and Industrial Telephone Systems. Kempster B. Miller. Reviewing the progress made since the expiration of the fundamental patents, especially in the introduction of private systems in mines, workshops, and other industrial establishments. 3500 w. Engineering Magazine—Jan., 1900. No. 31589 B.

DISTRIBUTION.

Alternating Currents.

Alternating Current Diagrams. Robert A. Philip. An illustrated explanation of a system of diagrams intended to represent graphically the relations between the various elements of an alternating current circuit. 3000 w. Elec Wld & Engr—Dec. 23, 1899. No. 31603.

Belgium.

The Future of the Distribution of Electric Energy in Belgium (L'Avenir des Distributions d'Energie Electrique en Belgique). M. Eric Gerard. A comparison of the possibility of the competition of steam with water-power in generating electricity, and a suggestion as to the use of blast furnace gases for power. 2000 w. Moniteur Industriel—Nov. 18, 1899. No. 31568 F.

Circuit Breakers.

Electrical Circuit Breakers. William Baxter, Jr. Explains the principle of circuit breakers and gives an illustrated description of various types. 1500 w. Am Mach—Nov. 30, 1899. Serial. 1st part. No. 31140.

Cut-Outs.

Design of Fusible Cut-Outs. B. H. Glover. A statement of facts bearing upon the proper design. 2000 w. W Elect'n—Dec. 2, 1899. No. 31175.

Network.

The Determination of the Best Number of Feeding Points for a Distribution Network (Bestimmung der Günstigsten Zahl von Speispunkten eines Vertheilungsnetzes). A. Sengel. A mathematical investigation, showing the most economical system to be that based on a number of equilateral triangles. Two articles, 7500 w. Elektrotech Zeitschr —Nov. 16, 23, 1899. No. 31549 each B.

Switches.

Methods of Suppressing Arcs in Switches, Fuses, etc. Ernest Kilburn Scott. Read before the Northern Soc. of Elec. Engs., England. Discusses some of the devices to suppress the arc. Ill. 2200 w. Elec Eng, Lond—Dec. 8, 1899. Serial. 1st part. No. 31394 A.

ELECTRO-CHEMISTRY.

Accumulator.

A Study of the Lead Accumulator (Studien am Bleiakkumulator). Martin Mugdan. An exhaustive examination of the chemical and electrical reactions which occur in the lead plate accumulator under various conditions of charging and discharging. 4500 w. Zeitschr f Elektrochemie—Dec. 7, 1899. No. 31561 G.

Electro-Chemistry.

Electro-Chemistry. Wilder D. Bancroft. On the importance of the study, considering points of interest and importance and its applications. 2800 w. Sib Jour of Engng—Dec., 1899. No. 31405 C.

Electrolysis.

The Hargreaves-Bird Electrolytic Alkali Process. John B. C. Kershaw. A consideration of the various reports which have been made upon this process. 1800 w. Elec Rev, Lond—Nov. 24, 1899. No. 31223 A.

The Present State of Industrial Electro-Chemistry (Etat Actuel de la Fabrication des Produits Chimiques par l'Electrolyse). Leon Guillet. An elaborate review of the electrolytic methods of producing the alkalies, chlorates, etc., on a commercial scale. Serial. Part I. 3000 w. Génie Civil—Nov. 25, 1899. No. 31501 D.

Electro-Metallurgy.

Some Notes on the Electro-Deposition of Zinc Under Pressure. Sherard Cowper-Coles. Illustrated description of experiments. 400 w. Elect'n, Lond—Dec. 1, 1899. No. 31325 A.

Electromotive Force.

Chemical Equivalents and Electromotive Force (Chemisches Gleichgewicht und Elektromotorische Kraft). H. Dauneel. A discussion of the theories of van't Hoff and Nernst upon the relation between the chemical equivalents of given substances and the electromotive force produced by their combination. 1500 w. Zeitschr f Elektrochemie—Nov. 23, 1899. No. 31560 G.

Voltaic Cells.

Seat of the E. M. F. in a Voltaic Cell. W. R. Cooper. From a book on "Primary Batteries," to be soon published. States various theories and concludes that it is largely a question of definition. 2300 w. Elect'n, Lond—Dec. 8, 1899. No. 31412 A.

Some Experiments on Voltaic Cells with Compound Electrodes. Frederick S. Spiers. Describes experiments that arose out of an investigation on the action of the zinc which is usually placed in boilers, and supposed to diminish electrolytic corrosion. Ill. 900 w. Elec Rev, Lond—Dec. 8, 1899. Serial. 1st part. No. 31413 A.

ELECTRO-PHYSICS.

Curves.

Deformed Curves (Ueber Deformirte Kurven). Rud. Goldschmidt. A discussion of the variations of alternating-current curves from the strict sinusoidal form, deriving equations for the complicated forms which sometimes occur. 2500 w. Elektrotech Zeitschr—Nov. 30, 1899. No. 31552 B.

The Experimental Plotting of Periodical Occurences in Physical Phenomena (Ueber die Experimentelle Aufzeichnung Periodischer Vorgänge aus Physikalischen Gebieten). Dr. R. Franke. Describing and illustrating apparatus for drawing the curves representing the waves of alternating currents. 4500 w. Elektrotech Zeitschr—Nov. 16, 1899. No. 31548 B.

Potential.

The Difference in Electric Conductors (Ueber einen Auffälligen Werth der Potentialdifferenz auf einem Stromdurchflossenden Leiter). H. Teege. A review of former experiments by Dr. Breisig, showing that the paradox of contradiction of Kirchhoff's law is only apparent. 1800 w. Elektrotech Zeitschr—Dec. 7, 1899. No. 31555 B.

Radiography.

Printing by X Rays (Imprimerie par les Rayons X). L. Le Roux. A general account of the Izambard process for reproducing manuscript or typewriting by use of Röntgen rays. 1200 w. L'Electricien—Dec. 16, 1899. No. 31564 B.

Windings.

Windings for Direct Current Electromagnets. Harold B. Smith. A study of the conditions under which a winding may be designed, with tabulated information. 3000 w. Jour Worcester Poly Inst—Nov., 1899. No. 31129 C.

GENERATING STATIONS.

Alternators.

The Applications of Monophase Alternators (Application des Alternateurs Monophasés). Illustrated description of methods of producing from monophase generators polyphase currents adapted for use with motors. 2500 w. Revue Technique—Dec. 10, 1899. No. 31516 D.

Bonn.

The Electric Plant of the City of Bonn (Das Elektricitätswerk der Stadt Bonn). Dr. Paul Bauer. With plan and section of the buildings, also details of the switchboard and the distribution. 7000 w. Elektrotech Zeitschr—Dec. 7, 1899. No. 31554 B.

Brushes.

Standardizing Carbon Brushes. E. Kilburn Scott. Gives tabulated sizes, suggesting that they be generally adopted, and also information concerning the quality and use. 1000 w. Elec Rev, Lond—Nov. 24, 1899. No. 31224 A.

Burnley.

Burnley Electricity Works. Illustrated detailed description of this English station, including the recent improvements. 3300 w. Elec Eng, Lond—Dec. 1, 1899. Serial. 1st part. No. 31323 A.

Commutators.

Commutator Design and Construction. Alton D. Adams. Discussion, with illustrations of the proper design and construction, and the importance to satisfactory operation. 3000 w. Am Elect'n —Dec., 1899. No. 31282.

Costs.

Influence of Cheap Fuels on the Cost of Electrical Energy. R. E. Crompton. Read before the Inst. of Elec. Engs., England. Discusses the three classes of cheap fuel available in England, and the form of furnace to burn them. Also editorial. 5500 w. Elec Rev, Lond—Dec. 1, 1899. No. 31322 A.

Double-Current Machines.

Transmission Problems for Modern Central Station Supply. The Use of Double-Current Machines. Eustace Thomas. Discusses the systems for a wide area of supply, and the use of the machines named. 1200 w. Elect'n, Lond—Dec. 1, 1899. No. 31326 A.

Electric Supply.

See Street and Electric Tramways.

Generators.

Double Voltage and Current Generators. Alton D. Adams, with editorial. An explanation of the position taken by the writer in a previous paper, which was criticized editorially. 2600 w. Elec Wld & Engr—Dec. 16, 1899. No. 31409.

Hydraulic Plant.

The Power Plant of the Merrill Railway and Lighting Co. F. E. Woodford. Illustrated description of a Wisconsin plant with a combined hydraulic and steam power station. 1000 w. Am Elect'n—Dec., 1899. No. 31281.

Hysteresis.

Hysteresis Loss in Armatures. Ernest Kilburn Scott. Brings up a number of interesting points, which are commented upon editorially. 1800 w. Elect'n, Lond—Dec. 8, 1899. No. 31411 A.

Independent Plants.

Electricity in Modern Buildings. Illustrated description of the various uses to which electricity is put in buildings, and of the apparatus needed to get the best results. 5200 w. Eng Rec—Dec. 2, 1899. No. 31199.

Italy.

Our Hydraulic Power (Le Nostre Forze Idrauliche). A. Raddi. A general review of the question of utilizing the many natural water powers of Italy, discussing the legal, political, and engineering features of the problem. Serial. Part I. 1800 w. Gior d Lav Pub e d Str Ferr—Nov. 8, 1899. No. 31573 B.

The Electric Plant at Salo, on Lake Garda (Impianto Elettrico della Societa Salo Gardone). Illustrated description of an interesting small plant. A head of 127 metres is utilised to drive Pelton wheels operating direct-connected dynamos. 2500 w. L'Industria—Nov. 12, 1899. No. 31572 D.

Municipal Plant.

An Ideal Municipal Electric Plant. Alton D. Adams. Discusses requirements and gives suggestions. 2800 w. Munic Engng—Dec., 1899. No. 31122 C.

The Grand Rapids, Mich., Municipal Central Station. Edward James Hart. Illustrated description. 1000 w. Elec Wld & Engr—Dec. 23, 1899. No. 31604.

Niagara.

Recent Additions in the Power House of the Niagara Falls Hydraulic Power and Manufacturing Company. Illustrated description of special machines for the generation of direct currents for electrochemical purposes from hydraulic power. 2700 w. Am Elect'n—Dec., 1899. No. 31280.

Parallel Driving.

Operating Alternators in Parallel. Describes the usual procedure in coupling. Ill. 1500 w. Power—Dec., 1899. No. 31436 C.

Parallel-Driving with Alternating Generators (Ueber den Parallelbetrieb mit Wechelstrommaschinen). Dr G. Benischke. A study of the conditions under which satisfactory parallel driving is practicable, with wave diagrams and a description of a mechanical model by which the action can be illustrated. 5000 w. Elektrotech Zeitschr—Dec. 14, 1899. No. 31558 B.

Power Station.

See Street and Electric Tramways.

Rotary Converters.

Some Notes on Rotary Converters, with Special Reference to the Extension Plant of the Chicago Edison Company. A. C. Eborall. Begins to present claims of the motor-generator as compared with the rotary converter. 2200 w. Elec Rev, Lond—Nov. 24, 1899. Serial. 1st part. No. 31222 A.

St. Gabriel, Canada.

Jacques-Cartier Water-Power Plant. Describes an interesting Canadian plant which utilizes a fall of 30 feet. Ill. 900 w. W. Elect'n—Dec. 9, 1899. No. 31-318.

Ticino.

The Hydro-Electric Plant of the Ticino at Vizzola (L'Impianto Idroelettrico di Vizzola Ticino). An illustrated description of the dam, canal, and power house. A fall of 28 metres is obtained and it is expected that 19,000 h. p. will be developed. Two articles, 2500 w. L'Elettricità—Nov. 4, 11, 1899. No. 31-567 each B.

HEATING AND WELDING.

Electrical Heating.

The Position of the Electrical Heating Industry in This Country. Discusses the position in England, and the reasons why progress has not been more rapid. Also the advantages. 1600 w. Elec Rev, Lond—Dec. 15, 1899. Serial. 1st part. No. 31607 A.

LIGHTING.

Australia.

Activity in the Electrical Field in Australia. C. Paulo Rei. A review of the rapid development of electric light plants and the construction of tramways, etc. 2200 w. W Elect'n—Dec. 2, 1899. No. 31177.

Hereford, Eng.

Hereford Electricity Works. Illustrated description of the lighting plant recently installed. 3500 w. Elec Eng, Lond—Dec. 15, 1899. Serial. 1st part. No. 31606 A.

Lamps.

The Incandescent Electric Lamp. Discusses recent statements in regard to their use and manufacture. 2200 w. Jour Gas Lgt—Dec. 12, 1899. No. 31451 A.

Miner's Lamp.

See Mining & Metallurgy, Mining.

Music Hall.

Electrical Features of the Fine Arts Building. Illustrated description of interesting features in a fine Chicago building. 2000 w. W Elect'n—Dec. 23, 1899. No. 31498.

Photometry.

The Spectrophotometry of Electric Lights (Sur la Spectrophotométrie des Lumières Electriques). Fernand Gaud. A communication to the French Academy giving the results of photometric measurements of the intensity of various parts of the spectra of different lights. 600 w. Comptes Rendus—Nov. 13, 1899. No. 31539 D.

St. Louis, Mo.

The Design and Construction of a Modern Central Lighting Station. H. H. Humphrey. A discussion of the design and construction of the plant of the Imperial Electric Light. Heat and Power Co., of St. Louis. Ill. 8000 w. Jour Assn of Engng Socs—Oct., 1899. No. 31126 C.

Windsor.

The Electric Lighting at Windsor. Illustrates and describes the application of electricity to street lighting. 1700 w. Elec Engr, Lond—Dec. 8, 1899. No. 31393 A.

MEASUREMENT.

Alternations.

Device for Measuring the Number of Alternations (Instrument zur Ermittelung der Wechselzahl). E. Stöckhardt. The number of vibrations is determined by the tone emitted from a tuning fork fitted with adjustable weights and actuated by the alternations of the current. 1000 w. Elektrotech Zeitschr—Dec. 14, 1899. No. 31559 B.

Power Factor.

Power Factor Measurement. Aug. J. Bowie, Jr. Mathematical discussion, giving curves and tables. 3000 w. Elec Wld & Engr—Dec. 9, 1899. No. 31314.

Pressure.

The Fall in Pressure in Alternating Generators (Ueber den Spaunungsabfall bei Wechelstromgeneratoren). B. A. Behrend. A comparison of the methods of Behn-Eschenburg and Rothert for measuring the fall in pressure, showing the latter to be untrustworthy. 3500 w. Elektrotech Zeitschr—Nov. 30, 1899. No. 31551 B.

Self Induction.

Measurements of Self-Induction of Various Kinds of Submarine Cables (Messungen über die Selbstinduktion Verschiedener Muster für Seekabel). Dr. F. Breisig. With sections of cables of various arrangements of cores and a description of the method of measurement of self-induction to be employed for each. 3500 w. Elektrotech Zeitschr—Nov. 30, 1899. No. 31553 B.

Switch.

Measuring Switch for High Tension Systems (Mess-Schaltung für Höchspannungs-Anlagen). L. Schüler. An illustrated description of a combined switching and measuring system, using a transformer to enable low pressure measuring instruments to be used. 1800 w. Elektrotech Zeitschr—Dec. 14, 1899. No. 31557 B.

POWER APPLICATIONS.

Agriculture.

Electric Energy in Agriculture (L'Energie Electrique en Agriculture). Paul Renaud. Chiefly devoted to the Zimmermann electric plow, with illustrations of construction, and details of performance. Serial, part I. 1500 w. Revue Technique—Dec. 10, 1899. No. 31513 D.

Alternating Motors.

Alternating-Current Power Motors. W. A. Layman. Discusses the difference between direct and alternating currents, and between direct and alternating-current motors, considering in detail the motor brought out by the Wagner Elec. Mfg. Co., of St. Louis. Ill. 5000 w. Jour Assn of Engng Soc's—Nov., 1899. No. 31488 C.

Arsenal.

The Application of Electric Energy at the Royal Arsenal at Spezia (L'Energia Elettrica pel Regio Arsenale Militare Marittimo della Spezia). A. Raddi. An argument in favor of the utilization of the river Magra as a source of power to be transmitted electrically to the arsenal at Spezia. 2500 w. Giord Lav Pub e d Str Ferr—Nov. 15, 1899. No. 31574 B.

Boats.

Electric Boats (Elektrische Boote). Max Büttner. With illustrations of various boats used in Germany, also giving construction of controllers and data as to the performance of the accumulators. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 25, 1899. No. 31521 D.

Electric Power.

See Mining and Metallurgy, Mining.

Enclosed Motor.

The Enclosed Electric Motor. Sydney F. Walker. Discusses the advantages and disadvantages, and things of importance in designing these motors. 2000 w. Elec Rev, Lond—Dec. 15, 1899. No. 31608 A.

Haulage.

Electric Haulage for Canals (Elek-

trische Kanalschleppschiffahrt). E. Müllendorff. Giving illustrations of various systems of electric traction for canals, with a comparison of their advantages. 2500 w. Glaser's Annalen—Nov. 15, 1899. No. 31534 D.

Induction.

Induction Motors. R. F. Markill. Describes the action of the induction motors and briefly reviews their history. 1100 w. Jour of Elec—Nov., 1899. No. 31429.

TRANSMISSION.

California.

The Mount Whitney Power Company. Illustrated description of a long-distance high-tension power transmission system in California. 2200 w. Elec Rev, N. Y. —Dec. 20, 1899. No. 31446.

Power Transmission.

Waterport-Albion Power Transmission. Orrin E. Dunlap. Illustrated description of a new plant in New York State. 1300 w. W. Elect'n—Dec. 2, 1899. No. 31176.

Three-Phase.

The Disposition of Three-Phase Transmission Lines. Aug. J Bowie, Jr. Discusses the arrangement of the wires and gives a mathematical solution showing the effect of unequal inductance in given examples. 2500 w. Jour of Elec—Nov., 1899. No. 31428.

MISCELLANY.

Address.

Prof. Sylvanus P. Thompson's Presidential Address to the Institution of Electrical Engineers. Discusses the progress of electrical engineering and the tendencies. 4000 w. Elect'n, Lond—Nov. 24, 1899. Serial. 1st part. No. 31227 A.

Japan.

Electricity in Japan. A review of the progress made, giving tabulated information of the Japanese electric companies and stations. Ill. 700 w. Elec Wld & Engr—Dec. 2, 1899. No. 31173.

GAS ENGINEERING

GAS ENGINEERING.

Acetylene.

Acetylene. A brief review of what has been learned regarding the manufacture and use, and of the work to which it has been satisfactorily applied. 1400 w. Builder—Nov. 25, 1899. No. 31232 A.

Acetylene Lighting. F. Cortez Wilson. Read before the Chicago Architects' Club. An outline of facts that have been determined in connection with acetylene lighting. 3300 w. San Plumb—Dec. 1, 1899. No .31308.

The Application of Acetylene Lighting to Railway Purposes (Die Anwendung der Acetylenbeleuchtung für Eisenbahnzwecke). Dr. Paul Wolff. A description of the installation of the Pietet-Wolff apparatus at the Schlachtensee Railway Station in Berlin. 3000 w. Ill. Zeitschr f Klein u Strassenbahnen—Oct. 16, 1899. No. 31576 D.

Ammonia.

Report on Sulphate of Ammonia Experiments. Report of Mr. John Hunter on the statistics of competitions for root growing in 1898. 1400 w. Gas Wld—Dec. 16, 1899. No. 31605 A.

Automatic Lighting.

The Besnard System of Automatically Lighting and Extinguishing Public Lamps. An illustrated description of an appliance for utilizing gas pressure. 1300 w. Jour Gas Lgt—Dec. 5, 1899. No. 31390 A.

Carbide.

Is Fine or Coarse Material to be Preferred in the Production of Calcium Carbide (Ist Fein Pulverisiertes oder Grob Gekörntes Rohmaterial bei der Herstellung von Calcuimcarbid Vorzuziehen?) Birger Carlson. Showing the advantages of using coarsely ground material over that reduced to a fine powder. 1800 w. Zeitschr f Elektrochemie—Dec. 7, 1899. No. 31563 G.

Coin Meters.

The Automatic Coin Meter. Norton H. Humphrys. Discusses their use, referring to recent papers and their discussions. 2700 w. Jour Gas Lgt—Dec. 12, 1899. No. 31452 A.

Electrical Gas.

An Alleged Electrical Gas Process. Exposing the worthlessness of the process being promoted by Dr. J. W. Chisholm. 3800 w. Eng News—Dec. 7, 1899. No. 31284.

Furnace Gases.

The Utilization of Blast-Furnace Gases in the Generation of Electricity. Considers its applicability, discussing its thermal and chemical qualities, and the methods tried. 2500 w. Elec Rev, Lond—Dec. 15, 1899. Serial. 1st part. No. 31609 A.

Utilization of High-Furnace Gases for Power in Gas Engines. Bryan Donkin. Discusses the application of these gases

to produce power, and describes the two-cycle engine. Ill. 2000 w. Engr, Lond—Nov. 24, 1899. Serial. 1st part. No. 31211 A.

Gasholders.

Gasholder Design (Gasbehälterführungen). H. Hacker. Methods of computing the stresses on gasholders of various kinds are given, especial consideration being given to wind stresses. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 25, 1899. No. 31522 D.

Gas Works.

Modern Improvements in the Plant of Gas Works: Especially With Reference to the Saving of Manual Labor. J. T. Westcott. Briefly outlines methods used in earlier works, and shows the labor-saving appliances now in use in the retort house. 3000 w. Am Gas Lgt Jour—Dec. 25, 1899. No. 31497.

Leakage.

Causes and Correction of Water and Gas Main Leakage. Gives statements made by various authorities concerning existing conditions, and discusses the remedy. 3500 w. Sci Am Sup—Dec. 23, 1899. No. 31440.

Legislation.

Some Disputed Points in Gas and Water Works Legislation. Thomas Newbigging. Read before the Manchester Dist. Inst. of Gas Engs. Also discussion. Considers the proper amount of the reserve fund, and the borrowing powers. 6000 w. Jour Gas Lgt—Nov. 28, 1899. No. 31245 A.

Mains.

Laying Gas and Water Mains in Public and Private Streets. Arthur Graham. Read before the Manchester Dist. Inst. of Gas Engs. Also discussion. Advises a pushing policy. Laying mains and if necessary giving outlets free. 2800 w. Jour Gas Lgt—Nov. 28, 1899. No. 31246 A.

Mantles.

Incandescent Mantles. Vivian B. Lewes. Lecture delivered before the members of the Incorporated Inst. of Gas Engs., England. Part first reviews the history and development of mantles, and gives some of the explanations of the wonderful light given. 4500 w. Gas Engs.' Mag—Dec. 11, 1899. Serial. 1st part. No. 31636 A.

Profit-Sharing.

Profit-Sharing, or Payment by Results. G. W. Lupton. Read before the Manchester Dist. Inst. of Gas Engs. Also discussion. Discusses this scheme favorably. 3800 w. Jour Gas Lgt—Nov. 28, 1899. No. 31247 A.

Water Gas.

Dellwick Water-Gas Process. Dr. G. Lunge. Translated from the *Journal für Gasbeleuchtung und Wasserversorgung.* A description of the Dellwick process as at present carried on, with statements concerning its advantages and value. Ill. 5400 w. Pro Age—Dec. 1, 1899. No. 31133.

Iron Carbonyl in Water Gas. M. van Breukelween and A. ter Horst, in *Het. Gas.* Abstract. On the inconveniences caused by its presence, with investigation of causes. 1000 w. Jour Gas Lgt—Nov. 21, 1899. No. 31165 A.

MARINE AND NAVAL ENGINEERING

Battleships.

Contract Trial of the United States Seagoing Battleship Kearsarge. Claude B. Price. Illustrated description of vessel and equipment, with report of trial. Plates. 6500 w. Jour Am Soc of Nav Engs—Nov., 1899. No. 31233 H.

Steam Trials of the Battleship Goliath. The engines are of the three-cylinder, inverted, triple-expansion type. The trials are described. 1000 w. Engr, Lond—Dec. 8, 1899. No. 31424 A.

Boats.

See Electrical Engineering, Power Applications.

Coast Defence.

The New French Armor-Clad "Henri Quatre." Brief illustrated description. 500 w. Sci Am—Dec. 9, 1899. No. 31260.

Cruisers.

Launch of H. M. S. Cressy. This is a sister ship of the Sutlej, previously described, so the description is principally devoted to special features, peculiar to this vessel. 2500 w. Engr, Lond—Dec. 8, 1899. No. 31423 A.

New Cruisers for the American Navy. Illustration, with description of vessels of the Chattanooga class. 1800 w. Engr, Lond—Nov. 24, 1899. No. 31215 A.

Ferrying.

Car Ferrying on the Great Lakes. Waldon Fawcett. Illustrates and describes some of the boats used in this service, giving an account of their efficiency. 1500 w. Loc Engng—Dec., 1899. No. 31146 C.

Gunnery.

Terms Used in Modern Gunnery. F.

Maurice. An explanation of such terms as "Creusot," "Krupp," "Shrapnel," "Common-Shell," "94-pounders," "4.7 inch guns," "Mausers," "Lee-Enfield," etc. 4800 w. Nineteenth Cent—Dec., 1899. No. 31385 D.

Launch Engine.

See Mechanical Engineering, Special Motors.

Liner.

The New Australian Liner "Ortona." Description, with report of trials. 1000 w. Engng—Nov. 24, 1899. No. 31209 A.

Lost Vessels.

Loss of the U. S. S. Charleston and Burning of the S. S. Patria at Sea. Illustrations of these vessels, and a brief account of the disasters. 900 w. Marine Engng—Dec., 1899. No. 31317 C.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Naval Architects.

Seventh General Meeting of the Society of Naval Architects and Marine Engineers. Report of the meeting, giving abstracts of papers and discussions. 31500 w. Marine Engng—Dec., 1899. No. 31315 C.

Oceanic.

The Steamship "Oceanic" (Le Paquebot "Oceanic"). M. Hachebet. A general description of the White Star liner, with numerous illustrations. 2500 w. Génie Civil—Nov. 25, 1899. No. 31500 D.

Piping.

Object-Lessons. A. B. Willits. On the installation of piping on steamships, and a peculiar condition of the propeller shaft of the Helena, which was ruptured. Ill. 1500 w. Jour Am Soc of Nav Engs—Nov., 1899. No. 31235 H.

Report.

The Annual Report of the Engineer-in-Chief. From the report of George W. Melville, giving the important parts. 18300 w. Jour Am Soc of Nav Engs—Nov., 1899. No. 31234 H.

Salvage.

Notable Salvage Operations of the Past Year. Waldon Fawcett. An interesting account of the work of the engineer in the peculiar field of saving and repairing wrecked and disabled vessels. With illustrations of recent important operations. 3000 w. Engineering Magazine—Jan., 1900. No. 31592 B.

Shipbuilding.

The Record of the Year in Steel Shipbuilding. Waldon Fawcett. Showing the development and advancement in the United States in 1899. 2500 w. Ir Age—Dec. 14, 1899. No. 31342.

Shipping Bill.

America's Shipping Bill. Arguments that accompany the bill and which are made a part of it, as introduced in the Fifty-Sixth Congress. 2200 w. Marine Rev—Dec. 14, 1899. No. 31388.

Steamers.

Shallow Draft Stern Wheel Steamers and Barges for Mexican Government. Illustrated description of interesting small vessels built at Algiers, La. 500 w. Marine Engng—Dec., 1899. No. 31316 C.

Submarine.

The "Goubet No. 2" at Toulon (Le "Goubet No. 2" à Toulon). Emile Duboc. A discussion of the merits of this submarine boat, as shown by its trip from St. Ouen to Toulon. A view of the boat in dry-dock is given. 1800 w. Le Yacht—Nov. 18, 1899. No. 31570 B.

The Problem of Submarine Navigation (Le Problème de la Navigation Sous-Marin). H. Noalhat. A discussion of the problems of immersion and orientation of submerged vessels, treated from a theoretical point of view. Serial, part I. 2000 w. Revue Technique—Dec. 10, 1899. No. 31515 D.

The Submarine Boat and Its Future. Waldon Fawcett. An outline of the recent tests of the Holland, and review of boats tried in France, with some of the views concerning the utility of such boats in warfare. Ill. 1700 w. Sci Am—Dec. 9, 1899. No. 31259.

Warships.

Recent British Warships. Considers three typical modern types of the British fleet, a battleship, a cruiser, and a torpedo boat destroyer. Colored supplement. 3000 w. Engr, Lond—Dec. 15, 1899. No. 31618 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

High-Pressure Gas Accumulators for Automobiles. An article intended to suggest a new line of thought and experiment in connection with accumulators. 1200 w. Automotor Jour—Dec., 1899. No. 31639 A.

Bicycles.

Motobicycles. From *La Nature*. Il-

lustrates and describes several new styles shown at the last automobile exhibition. 1200 w. Sci Am Sup—Dec. 9, 1899. No. 31261.

Boiler Feeding.

Boiler Feeding Apparatus. R. I. Clegg. Illustrates and describes various devices. 4000 w. Horseless Age—Dec. 6, 1899. No. 31274.

Burners.

Oil Fuel Burners. R. I. Clegg. Illustrates and describes three representative types. 2500 w. Horseless Age—Dec. 6, 1899. No. 31275.

Circulation.

Advantages of Circulation. S. D. Mott. Showing how the efficiency is increased by circulation. 2000 w. Horseless Age—Dec. 6, 1899. No. 31272.

Construction.

Recent Progress in Automobile Construction. W. Worby Beaumont. A review of the progress in details of motor vehicle construction during the past two years, showing the lines of advance in the removal of the mechanical imperfections revealed by experience. 3000 w. Engineering Magazine—Jan., 1900. No. 31587 B.

Exposition.

The Electric Carriages at the International Motor-Vehicle Exposition (Elektrische Fahrzeuge auf der Internationalen Motorwagen Ausstellung). Franz Wilking. With numerous illustrations of early and recent vehicles, and an extensive table giving details and dimensions of the various exhibits. 6000 w. Elektrotech Zeitschr—Nov. 23, 1899. No. 31550 B.

Fire Engine.

The Horseless Fire Engine. Captain Cordier. Illustrates and describes various machines in use or being constructed, with experimental information. 2800 w. Auto Mag—Dec., 1899. No. 31130 C.

Fuel.

A New Automobile Fuel, Electrolytic Alcohol. George H. Benjamin's account of automobilism in Russia, and of the low-priced, odorless fuel used. Ill. 1200 w. Elec Rev, N. Y.—Dec. 13, 1899. No. 31370.

Hose Wagon.

An Electric Hose Wagon. From *Le Magasin Pittoresque*. Illustrated description of a vehicle belonging to the Paris fire department. 1000 w. Sci Am—Dec. 23, 1899. No. 31439.

Military Vehicle.

A Military Motor Carriage. Illustrates and describes a three-wheeled motor carriage for military use, designed by R. P. Davidson. 450 w. Eng News—Dec. 7, 1899. No. 31283.

Motor Car.

The Alldays and Onion's Motor Car. Illustrated brief description of a four-seated petroleum-spirit motor car. 450 w. Ind & Ir—Dec. 1, 1899. No. 31328 A.

Motor.

La Voiture Darracq. Adapted from an article by L. Baudry de Saunier in *La Locomotion Automobile*. Illustrated description of a vehicle designed for general use. 1000 w. Automotor Jour—Dec., 1899. No. 31638 A.

New Motor Vehicles. Brief illustrated descriptions of the Humber motor vehicles, the "Star" motor car, and the "Swiss Mountaineer" car. 1000 w. Ind & Ir—Dec. 8, 1899. No. 31414 A.

The George Richard Carriage (La Voiture Georges Richard). Gaston Sencier. An account of the Richard petroleum automobile, describing the manipulation, and giving a list of the important events in which it has participated. 2500 w. Revue Technique—Nov. 25, 1899. No. 31512 D.

The Georges Richard Motor Carriage. Illustrates and describes this vehicle, its management, and care needed, giving also results of some races. 2000 w. Automotor Jour—Dec., 1899. No. 31640 A.

The Locomobile. R. I. Clegg. Illustrated description of the operating mechanism. 1800 w. Horseless Age—Dec. 6, 1899. No. 31276.

Petroleum.

The Bennett and Thomas Petrol Motor. Illustrated description of a motor claiming the advantages of absence of vibration, noiseless, smooth running and simplicity. 1200 w. Automotor Jour—Dec., 1899. No. 31637 A.

Racing Car.

The Vallée Racing Car. Illustrates and describes a car constructed for racing, noting its special features. 600 w. Ind & Ir—Dec. 1, 1899. No. 31329 A.

Record.

A Record Making Automobile. J. B. Entz and H. P. Maxim. Illustrations and details of the electric automobile which lately brought the world's record for these vehicles to this country. 2000 w. Elec Wld & Engr—Dec. 23, 1899. No. 31601.

Stanley Show.

Cycles and Motor Cars at the Stanley Show. Editorial review of the exhibits, noting the novel features. 4200 w. Engng—Nov. 24, 1899. No. 31208 A.

Station.

The Newport (R. I.) Electrical Automobile Station. Spencer C. Crane. An illustrated description of the station and vehicles of the New England Electric Vehicle Transportation Co., with an account of the success of the enterprise. 2500 w. Elec Wld & Engr—Dec. 16, 1899. No. 31407.

Steam Car.

The Stanley Steam Car. Illustrated description. 1200 w. Ind & Ir—Dec. 15, 1899. No. 31613 A.

Traction Engines.

Traction Engines in South Africa. Illustrates and describes these engines, showing the development to fit them for Colonial work. Report of the commission sent out to obtain information of their work. 3800 w. Engr, Lond—Dec. 8, 1899. No. 31425 A.

Traction Engines in War. Illustrated description of these engines, about to be given a trial in the Transvaal campaign. 600 w. Engr, Lond—Nov. 24, 1899. No. 31216 A.

Vehicle Boilers.

Considerations in the Design of Vehicle Boilers. P. M. Heldt. Discusses the time required in the operation, the fuel, types of boilers, etc. 2200 w. Horseless Age—Dec. 6, 1899. No. 31273.

Steam Boilers for Motor Vehicles. R. I. Clegg. An illustrated historical review. 7400 w. Horseless Age—Dec. 6, 1899. No. 31271.

Wheels.

The World on Wheels. Edwin Emerson, Jr. Historical review of the progress of wheeled vehicles. Ill. 2400 w. Auto Mag—Dec., 1899. No. 31131 C.

HYDRAULICS.

Pumping Engines.

Comparison Between High and Low Duty Pumping Engines on a Small Water Works Plant. John E. Smith. Facts from the reports of the Andover Water Commissions for 1895, '96 and '97. Describes the conditions and system with improvements. 3400 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31383 E.

Pumping.

The Kaselowsky Pumping System. Charles Francois. Abstract of paper in the *Revue Universelle des Mines.* Illustrates and describes a subterranean pump operated by hydraulic pressure. 700 w. Eng & Min Jour—Dec. 23, 1899. No. 31496.

Turbine.

The Construction and Operation of the Transformer Turbine (Bericht über die Konstruktion und Wirkungsweise der Transformator Turbine). F. Prásil. A description of the improved turbine by which sufficiently high speeds may be obtained for direct driving of electric generators from low-pressure water. Three articles, 7500 w. Schweizerische Bauzeitung—Nov. 25, Dec. 2, 9, 1899. No. 31538 each B.

Water Wheels.

Some Old-Time Water Wheels. William Wallace Christie. Historical review of wheels used for water power, giving information of interest. 1500 w. Eng News—Dec. 21, 1899. No. 31460.

MACHINE WORKS AND FOUNDRIES.

Brass Furnace.

A German Brass Furnace. An illustrated description of a furnace near Chemnitz, which differs in construction and operation from American practice. 2000 w. Foundry—Dec., 1899. No. 31443.

Casting.

Casting a Header in the Floor. R. H. Palmer. Illustrated description of the work. 2200 w. Am Mach—Dec. 28, 1899. No. 31633.

The Casting of Plates. R. H. Palmer. Suggestions concerning methods of molding. Ill. 1000 w. Foundry—Dec., 1899. No. 31444.

Cranes.

Modern Electric Cranes (Neuere Elektrisch Betriebene Hebezeuge). With illustrations of the construction and method of erection of the 150 ton electric crane recently built by the Benrath Machine Works for the port of Bremerhaven. 3000 w. 1 plate. Zeitschr d Ver Deutscher Ing—December 2, 1899. No. 31523 D.

Radial Crane of 100 Tons Capacity (Grue Pivotante de 100 Tonnes). Illustrated description of large steam wharf-crane of variable radius, recently installed at the shipbuilding establishment of Blohm & Voss, at Hamburg. 1500 w. Génie Civil—Dec. 2, 1899. No. 31503 D.

Dies.

Making a Compound Die for Punching an Irregular Piece in a Sub-press. Lundvald and Klute. Illustrated description of best method of construction. 1500 w. Am Mach—Dec. 28, 1899. No. 31632.

Lathes.

44-inch Turret Chucking and Turning Lathe. Illustrated description of a machine designed by John J. Grant. 600 w. Am Mach—Nov. 30, 1899. No. 31142.

Machine Tools.

Machine Tools at the Stanley Show. Illustrated account of such machines as

were shown for the first time. 5700 w. Engng—Nov. 24, 1899. No. 31206 A.

Planing.

A Much Extended Planer Tool. Oberlin Smith. Illustrated description of a special tool with a "nose" about 8 feet long. 1000 w. Am Mach—Dec. 21, 1899. No. 31431.

Premium System.

Actual Experience with the Premium System. H. M. Norris. An interesting account of an attempt to introduce the premium system into an American works, and the obstructive attitude assumed by union labor. 5000 w. Engineering Magazine—Jan., 1900. No. 31591 B.

The Reference or Premium Plan. Isaac Ross. An explanation of a system that has been worked successfully for seven years. 1500 w. Am Mach—Dec. 7, 1899. No. 31266.

Projectiles.

The Making of Large Projectiles. Jas. A. Murphy. Illustrated description. 1300 w. Foundry—Dec., 1899. No. 31-445.

Pulp Machines.

Machines for the Manufacture of Wood Pulp (Machines à Fabriquer la Pate de Bois et le Carton). With illustrations of wood-grinding and pasteboard machines. 1200 w. 1 plate. Génie Civil—Dec. 2, 1899. No. 31504 D.

Shop-Practice.

The Revolution in Machine Shop Practice. Henry Roland. Mr. Roland's fourth paper discusses the practical limitations of tool making as illustrated by the very highly-organized automatic machines used in an American watch factory. 3500 w. Engineering Magazine—Jan., 1900. No. 31588 B.

Shops.

Shops of Baker Brothers, Toledo, Ohio. Illustrated detailed description of new works made necessary by growing business. 1200 w. Am Mach—Dec. 14, 1899. No. 31369.

Staybolts.

Stay bolt Progress. Considers material used, form of the fire box, and of stay bolts, riveting, etc., with conclusions. Ill. 5200 w. Am Engr & R R Jour—Dec., 1899. No. 31178 C.

Sweden.

The New Atlas Works, Stockholm. Illustrated detailed description. 2000 w. Am Mach—Nov. 30, 1899. No. 31143.

MATERIALS OF CONSTRUCTION.

Bursting Strength.

The Expansion of Thick Cylinders Under Bursting Pressure—Pressing on Thick and Thin Disks. J. H. Dunbar. Illustrated description of experiments made to note the change in shape likely to take place in the hubs of cast-iron wheels when pressed on by hydraulic presses. 1000 w. Am Mach—Dec. 7, 1899. No. 31269.

Copper.

Copper in Steel. Albert Ladd Colby. A summary of the report presented at Philadelphia meeting, Nov. 17, of the Am. Soc. of the International Assn. for Testing Materials and the Assn. of Am. Steel Mfrs. Discusses experiments. 6000 w. Ir Age—Nov. 30, 1899. No. 31120.

Elasticity.

The Elasticity of Steel Balls and Plates. Alton L. Smith. Concerning ball-bearings and tests recently made. Ill. 2000 w. Jour of Worcester Poly Inst—Nov., 1899. No. 31128 C.

Sheet Iron.

Computations for Rectangular Sheet iron Plates (Calcul des Tôles Rectangulaires). M. Koechlin. A mathematical discussion of the strength of a rectangular plate of sheet iron supported at two or four edges, and uniformly loaded over the entire surface. 2500 w. Génie Civil—Nov. 25, 1899. No. 31502 D.

POWER AND TRANSMISSION.

Belt Dressings.

Effect on Transmitting Power of Belts of Dressing with Special Materials. R. C. Carpenter. A report of Sibley College tests, showing that the carrying capacity of a belt may be very much increased by dressings. 1600 w. Ill. Sib Jour of Engng—Dec., 1899. No. 31-406 C.

Compressed Air.

Compressed Air in the Shop. Illustrated description of air compressors and compressed air appliances. 5500 w. Mach, N. Y.—Dec., 1899. No. 31151.

Report on Trials Made at Magog, Quebec, to Test the Economy Effected by Compressed Air. J. T. Nicolsen. Trials were made at the Dominion Cotton Mill, where there is installed a 150-h. p. hydraulic air-compressing plant. 1600 w. Can Elec News—Dec., 1899. No. 31389.

Some Compressed Air Queries. Frank Richards. An explanation of some points in the writer's book on "Compressed Air," called out by a letter from Ireland. 1400 w. Am Mach—Dec. 7, 1899. No. 31267.

Gearing.

Electric Driving by Toothed Gearing (Elektrischer Antrieb mittels Zahnradübertragung). O. Lasche. Especially

devoted to the influence of the form of tooth upon the wear. The conditions of durability in electric tramway service are considered. Three articles, 10000 w. Zeitschr d Ver Deutscher Ing—Nov. 18, Dec. 2, 9, 1899. No. 31518 each D.

The Grisson Driving Gear (Grisson-Getriebe). R. Grisson. An illustrated description of a gear for use with tramway motors. Two heart-shaped cams engage with rollers mounted on a driven disk. 3500 w. Die Elektrizität—Nov. 25, 1899. No. 31565 B.

Tumbler Gearing. P. J. Connor. Illustrates a useful device for reversing the motion of driven shafts. 500 w. Mach, N. Y.—Dec., 1899. No. 31153.

Pneumatic Tube.

Pneumatic Mail Transmission for Chicago. Reviews the introduction of this system in the United States, and the plans for Chicago. 1200 w. Mod Mach—Dec., 1899. No. 31171.

Shafting.

Flywheel Effects on Shafting. W. H. Booth. Discusses this subject and the difference between American and English practice. 1200 w. Am Mach—Nov. 30, 1899. No. 31141.

Transport Appliances.

Mechanical Transport in Mining and Engineering Works. A. J. S. B. Little. Mr. Little's second paper is devoted to many forms of labor-saving appliances in connection with ore-handling and metallurgical processes. 3500 w. Engineering Magazine—Jan., 1900. No. 31-586 B.

SPECIAL MOTORS.

Furnace Gases.

See Gas Engineering.

Gas Engine Plant.

A Large Double-Acting Two-Cylinder Gas Engine. Illustrated description of a plant used for operating the dynamos of an electric railway. 1200 w. Eng Rec—Dec. 2, 1899. No. 31198.

Gas Engines.

Future of the Gas Engine. M. A. Hicksman. On the expansion that may be looked for in connection with recent developments, especially in the large units. 1000 w. Mod Mach—Dec., 1899. No. 31170.

Gas Engine Guarantees. William T. Magruder. Abstract of paper read at meeting of the Nat. Assn. of Gas and Gasoline Eng. Mfrs. Considers such guarantees as power ratings, regulation, cost of running and fuel consumption. 3500 w. Mod Mach—Dec., 1899. No. 31172.

Motor.

The Kinetic Motor. Describes this motor, now in use between Babylon and Farmingdale, on the Long Is. Ry. and illustrates one of the trucks. 900 w. R R Gaz—Dec. 1, 1899. No. 31163.

Petroleum.

Petroleum Motors for Coal Mine Haulage. M. J. Kersten. Abstract of a paper in *Annales de Mines de Belgique.* Describes a type of locomotive working with benzine, which is claimed to be safe and economical. 900 w. Eng & Min Jour—Dec. 16, 1899. No. 31395.

STEAM ENGINEERING.

Boiler Compounds.

The Use of Boiler Compounds. Albert A. Cary. Divides these compounds into three divisions, discussing each in detail. 3500 w. Am Mach—Dec. 7, 1899. No. 31268.

Compound Engine.

Single-Cylinder Compound Steam Engine (Eincylinder-Verbunddampfmaschine). C. Sondermann. A trunk piston is used, with an annular space in the middle portion, serving as a high-pressure cylinder. 1500 w. Zeitschr d Ver Deutscher Ing—Dec. 9, 1899. No. 31-525 D

Condenser.

Central Condensing Plants for Ironworks. W. H. Roy. Read before the West of Scotland Iron and Steel Inst. A discussion of points to be kept in mind, types, etc., illustrating and describing various plants. 3500 w. Col Guard—Nov. 24, 1899. Serial. 1st part. No. 31219 A.

Engine Efficiency.

Logarithmic-Graphical Method of Determining the Power and Efficiency of Steam Engines (Logarithmisch-Zeichnerisches Verfahren zur Bestimmung des Arbeit und des Gütegrades der Dampfmaschinen). A. S. Oesterreicher. With graphical diagrams for enabling the capacity and efficiency of steam engines to be determined with a minimum of calculation. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 18, 1899. No. 31-519 D.

Exposition.

The Power Plant of the Exposition of 1900 (Le Service des Installations Mécaniques á l'Exposition de 1900). G. Leugny. A general view of the great power-house of the exposition, with especial details of the flues leading to the great chimneys and the subways for steam and water pipes. 2000 w. Revue Technique—Dec. 10, 1899. No. 31514 D.

The Power Plant of the Paris Exposition. An illustrated description. 1400 w. Power—Dec., 1899. No. 31-435 C.

Fuel Economy.

Fuel Economy Resulting from a Study of Indicator Cards. W. E. Symons. From a discussion of the report: To What Extent Do Draft Appliances, Valves and Valve-Setting and Cylinder Packing Influence Economy of Fuel, presented at the Atlanta meeting of the Southern and Southwestern Railway Club. 900 w. R R Gaz—Dec. 29, 1899. No. 31630.

Furnaces.

Furnace Efficiency. A. Bement. Considers other losses than those arising from incomplete combustion and other conditions which may decide superiority. 2200 w. Power—Dec., 1899. No. 31438 C.

Governors.

The Fly-Ball Governor. H. H. Kelley. An illustrated description of this class of governors and their operation. 1500 w. Engr, U. S. A.—Dec. 15, 1899. Serial. 1st part. No. 31430.

Indicator.

A Continuous Mean-Pressure Indicator for Steam-Engines. William Ripper. Gives description of the instrument; short-stroke type; long-stroke type, time-pressure diagrams. Relation between time-pressure and distance-pressure diagrams, etc. Ill. 4500 w. Inst of Mech Engs—Dec. 8, 1899. No. 31391 D.

Launch Engine.

The Griffin Oil Launch Engine. Illustrated detailed description. 1600 w. Engng—Nov. 24, 1899. No. 31210 A.

Marine Engines.

Engines of H. M. First-Class Battleship Ocean. Illustrations and description of engines of the triple-expansion type, steam being supplied by Belleville boilers. 900 w. Engr, Lond—Dec. 1, 1899. No. 31345 A.

The Engines of British Cruisers (Machines de Croiseurs Anglais). With illustrations and descriptions of the engines of the Proserpine and the Psyche. 1200 w. Revue Technique—Nov. 10, 1899. No. 31507 D.

Triple-Expansion Engines of the Dutch Cruiser Noord Brabant. Illustrated details of the engines and machinery. 1600 w. Engr, Lond—Dec. 8, 1899. No. 31422 A.

Moisture.

Moisture in Steam (De l'Humidité de la Vapeur). N. François. A discussion of the various methods of determining the proportion of water entrained in steam. 6000 w. Rev Univ des Mines—Nov., 1899. No. 31582 G.

Power-House Engines.

The Steam Engine for the Electric-Traction Power-House. C. A. Hague. Mr. Hague's second paper discusses detailed problems in design as well as in the erection of large steam units, giving valuable illustrations from the best current practice. 3000 w. Engineering Magazine—Jan., 1900. No. 31590 B.

Steam.

The Cost of Steam Raising. John Holliday. Read before the Inst. of Elec. Engs., England. Discusses the cost of producing steam without reference to the production of power, considering the different items. 5800 w. Elec Eng, Lond—Nov. 24, 1899. No. 31228 A.

Superheating.

Superheating Steam. J. H. Ashby. Abstract of paper read before the Cleveland Inst. of Engs. Aiming to show the advantages of superheating, especially in the Cleveland district. Discussion. 3500 w. Col Guard—Dec. 15, 1899. No. 31622 A.

Test.

Test of a Direct-Connected Railway Unit at Different Loads. Gives the results of tests of a 300-K. W. plant comprising water-tube boiler, horizontal compound condensing engine with double eccentrics, and a 6-pole generator. 900 w. Eng Rec—Dec. 23, 1899. No. 31485.

Thermal Efficiency.

The Thermal Efficiency of Steam Engines. Main portion of the report of the committee appointed by the Institution of Civil Engineers to consider a standard or standards of thermal efficiency for steam engines. 8500 w. Jour Am Soc of Nav Engs—Nov., 1899. No. 31237 H.

Valve Gear.

Investigations Upon Regulation With the Rider Valve Gear (Versuche über die Regulirung der Rider-Steverung). Dr. Camerer. An examination of the Rider valve-gear, with especial reference to the influence of friction upon regulation. Two articles. 7000 w. Zeitschr d Ver Deutscher Ing—Nov. 25, Dec. 2, 1899. No. 31520 each D.

MISCELLANY.

Air Resistance.

The Resistance of the Air. G. H Bryan. An account of the investigations of MM. l'Abbé Le Dantec and Canovetti. 1700 w. Nature—Nov. 30, 1899. No. 31319 A.

Artillery.

Siege Artillery. G. N. Whistler. Discusses the question of siege artillery and

the conditions which have been produced by the introduction of the modern high-powered gun. 6500 w. Jour U. S. Artillery—No. 40, 1899. No. 31489 F.

The Determination of the Jump in Guns. John P. Wisser. Illustrates and describes a method of charting and measuring vibration by the use of electrical methods. 1200 w. Elec Rev, N. Y.—Dec. 27, 1899. No. 31635.

China.

Openings for Mechanical Engineers in China. Lord Charles Beresford. Read at meeting of British Inst. of Mech. Engs. Considers openings under the heads of: 1. Railways and electrical engineering. 2. Mining and allied works. 3. Manufacturers. Also discussion. 7800 w. Engng—Dec. 1, 1899. No. 31330 A.

Coast Fortifications.

The Gruson Chilled Cast-Iron Turrets to Be Manufactured in the United States. An illustrated description of the Gruson Turret, with an account of tests, and the preparations for their manufacture in this country. 3300 w. Ir Age—Dec. 28, 1899. No. 31626.

Discharge.

The Discharge of Gases and Vapours (Sur l'Ecoulement des Gaz et des Vapeurs). A translation of the paper Prof. Weyrauch recently published in the *Zeitschrift des Vereines deutscher Ingenieure*. 6000 w. Revue Technique—Nov. 10, 1899. No. 31510 D.

Education.

The Centennial Celebration of the Royal Technical High School at Berlin (Die Hundertjahrfeier der Königlichen Technischen Hochschule zu Berlin). M. Geitel. A brief history of the institution, together with an account of the recent celebration and a view of the buildings. 3500 w. Glaser's Annalen—Nov. 1, 1899. No. 31533 D.

The Question of Degrees in the Prussian Technical High Schools (Die Titelfrage an den Preussischen Technischen Hochschulen). Dr. P. v. Salvisberg. A discussion of the recent decree of the Emperor giving the right to confer the higher degrees to the technical high schools. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 2, 1899. No. 31546 B.

Elevator.

The Elevator at Saint-Germain-en-Laye (L'Ascenseur de Saint-Germain-en-Laye). Illustrated description of hydraulic elevator of 33 metres lift, by which the height of Saint-Germain-en-Laye, near Paris, is reached. 3000 w. Revue Technique—Nov. 25, 1899. No. 31511 D.

Export Exposition.

The National Export Exposition at Philadelphia. Illustrations of some of the interesting exhibits and an account of the exhibition. 6000 w. Power—Dec., 1899. No. 31437 C.

Liquid Air.

Latent Heat of Evaporation of Liquid Air. Walter H. Dickerson. Describes investigations, giving results. 1000 w. Compressed Air—Dec., 1899. No. 31167.

Pyrometers.

Pyrometers. Wallace Christie. A brief description of various methods that have been used for measuring high temperatures. Ill. 2000 w. Mach, N. Y.—Dec., 1899. No. 31152.

Refrigeration.

Hotel and Restaurant Refrigeration. E. T. Skinkle. Notes the special requirements and gives plan and elevation for modern cold storage room, and sectional views of "short order" box. 2200 w. Ice & Refrig—Dec., 1899. No. 31203 C.

The Refrigeration of Dwellings. E. Brueckner. Shows the importance of pure cold air, and discusses the development of mechanical refrigeration and the scientific principles. 2300 w. Ice & Refrig—Dec., 1899. Serial. 1st part. No. 31204 C.

Sighting.

Automatic Sighting. H. S. S. Watkin. Reprinted from Pro. Royal Art. Inst. Discusses the theory and practice. Ill. 2400 w. Jour U. S. Artillery—No. 40, 1899. No. 31490 F.

Sugar Plants.

Sugar Machinery. Illustrated description of an installation of sugar machinery, with the crystallization in motion plant. 3500 w. Engng—Dec. 8, 1899. No. 31415 A.

MINING AND METALLURGY

COAL AND COKE.

British Coal.

The Coal Trade Centers of the United Kingdom. Part first illustrates and describes Cardiff. 3800 w. Ir & Coal Trds Rev—Nov. 24, 1899. Serial. 1st part. No. 31220 A.

Coals.

The Combustibility of Coals. O. Lang, in *Glückauf*. Investigations of the

causes of spontaneous combustion. 1200 w. Am Mfr & Ir Wld—Dec. 7, 1899. No. 31277.

Coal Stamping.

An Electrically-Driven Coal-Stamping Machine. From *Glückauf*. Illustrated description of a machine used in preparing inferior coal for coking. 1300 w. Ir & Coal Trds Rev—Dec. 1, 1899. No. 31332 A.

Coal Stamping Machinery (Ueber Kohlenstampfmaschinen). A description of machinery used for consolidating soft coal preparatory to coking; with especial reference to the electrically driven machines now used in Silesia and in the Saar district. 1500 w. 1 plate. Glückauf—Nov. 25, 1899. No. 31541 B.

Coal Working.

New Method of Working at the Grand 'Combe Colliery. M. Destiral. From a communication to the Société de l'Industrie Minérale, St. Etienne. Illustrates and describes the method, discussing the cases in which it is applicable and its advantages. 3300 w. Col Guard—Dec. 8, 1899. No. 31418 A.

Coke-Making.

The Improved Otto System of Coke-Making. From *Stahl und Eisen*. Concerning the improved type of the Otto ovens, in which the regenerative principle has been abandoned, and the cause of the alteration. 1200 w. Col Guard—Dec. 8, 1899. No. 31419 A.

The Otto Coke Oven in Germany. Translated from *Glückauf*. Illustrates the new type of Otto oven, heated from below, stating the advantages, and giving analyses. 3300 w. Ir & Coal Trds Rev—Dec. 8, 1899. No. 31427 A.

Some Systems of Coking and Coke Ovens. Brief accounts of the various systems, with illustrations. 3500 w. Ir & Coal Trds Rev—Dec. 1, 1899. No. 31334 A.

Underfired Coke Ovens (Koksöfen mit Unterfeuerung). K. Hilgenstock. Especially describing the improved Otto by-product coke oven, with sectional details showing the construction. 3500 w. 1 plate. Glückauf—Dec. 2, 1899. No. 31542 B.

Indiana.

Coal Mining in Indiana. George H. Ashley. Abstract from the annual report of the Dept. of Geol. and Nat. Resources of the State of Indiana. Describes the geological features and methods of working. 4500 w. Mines & Min—Dec., 1899. No. 31251 C.

Queensland.

The Coal Beds of Queensland. T. Pearson Moody. From a paper read before the South Wales Inst. of Engs. Describes the deposits. 1600 w. Col Guard—Dec. 15, 1899. No. 31621 A.

Spontaneous Ignition.

Spontaneous Ignition of Coal. Extract from a report to the Sec. of the U. S. Navy, showing the conditions under which it occurs in bituminous coal, and how it may be guarded against. 3500 w. Mines & Min—Dec., 1899. No. 31250 C.

Victoria.

The Coalfields. On the fields of Victoria and their reliability. 1700 w. Aust Min Stand (special)—June 1, 1899. No. 31353 D.

COPPER.

Assaying.

Present Commercial Methods of Copper Assaying and Analysis. Titus Ulke. An outline of the daily work of a copper works chemist and assayer at a large refinery. 2700 w. Eng & Min Jour—Dec. 16, 1899. No. 31397.

Reduction-Roasting.

Reduction-Roasting—Its Value for Arsenic-Expulsion from Copper Ores and Mattes. Emilius W. Scherr, Jr. Describes investigations to ascertain to what extent arsenic is expelled from a previously well-roasted copper matte by a subsequent reducing roast with charcoal, the arsenic at the start being in combination with iron as arsenopyrite. 2500 w. Sch of Mines Quar—Nov., 1899. No. 31649 D.

Refining.

The Electrolytic and Mechanical Refining of Copper. J. Ohly. Reviews the history of the application of electrolysis, and its extensive use in the industries. 1200 w. Min Rept—Dec. 14, 1899. Serial. 1st part. No. 31420.

GOLD AND SILVER.

Ararat

The Ararat District. An illustrated account of its discovery and conformation, mines, etc. 1000 w. Aust Min Stand (special)—June 1, 1899. No. 31357 D.

Ballarat.

Famous Mines of Ballarat. Illustrated descriptions are briefly given. 3500 w. Aust Min Stand (special)—June 1, 1899. No. 31347 D.

Beechworth.

The Beechworth District. An illustrated description of this district, its mines and their development, methods, etc. 24500 w. Aust Min Stand (special)—June 1, 1899. No. 31354 D.

Bendigo.

The Bendigo District. An illustrated account of the city and surroundings,

mines, deposits, development, etc. 50000 w. Aust Min Stand (special)—June 1, 1899. No. 31350 D.

British Columbia.

The Big Bend of the Columbia River. W. M. Brewer. Facts relating to the mines of this district. 1200 w. Eng & Min Jour—Dec. 2, 1899. No. 31187.

The Boundary District, British Columbia. Charles A. Bramble. Describes preparations made to work the mines of this district. 1400 w. Eng & Min Jour—Dec. 9, 1899. No. 31279.

The Granby Smelter, Boundary District, British Columbia. Charles A. Bramble. An illustrated description of the plant in process of erection. 2200 w. Eng & Min Jour—Dec. 16, 1899. No. 31398.

California.

Calaveras County Mines. Arthur Lakes. Illustrates and describes Angels Camp and the mother lode in Tuolumne County. 2400 w. Mines & Min—Dec., 1899. No. 31249 C.

The Upper Coffee Creek Mining District. Oscar H. Hershey. Arguments aiming to prove the permanent character of these mines. 1000 w. Min & Sci Pr—Dec. 16, 1899. No. 31442.

Castlemaine.

The Castlemaine District. Gives an illustrated description, noting its rise and progress, geology, mines etc. 14200 w. Aust Min Stand (special)—June 1, 1899. No. 31356 D.

Creswick.

Creswick. H. A. Westmoreland. Illustrated description of this valuable quartz goldfield. 2500 w. Aust Min Stand (special)—June 1, 1899. No. 31348 D.

Cripple Creek.

The Cripple Creek Gold Field. T. A. Rickard. Condensed from a paper read before the Inst. of Min. and Met. Part first describes the physical features of the district, and its geology. Ill. 2500 w. Min & Sci Pr—Dec. 16, 1899. Serial. 1st part. No. 31441.

Deep Leads.

The Deep Leads of Victoria. E. Lidgey. Describes the deposits and the wealth they have been proved to contain. 4200 w. Aust Min Stand (special)—June 1, 1989. No. 31361 D.

The London Valley Deep Leads. Reginald A. F. Murray. From the report of the government geologist. Descriptive. 2500 w. Aust Min Stand (special)—June 1, 1899. No. 31349 D.

Dredging.

Australian Dredging Progress. Explains the various operations usually confused with dredging proper, and gives an account of the work erroneously called hydraulic dredging in Victoria and New South Wales. 5500 w. Aust Min Stand (special)—June 1, 1899. No. 31364 D.

Dredging for Gold. Gives a detailed account of the evolution of the modern dredge as used for gold recovery. Ill. 5200 w. Aust Min Stand (special)—June 1, 1899. No. 31363 D.

Gold Dredging in New Zealand. W. M. Mackinnon. Illustrated description of the methods used in the district of Otago. 1500 w. B. C. Min Rec—Dec., 1899. No. 31371 C.

Drift Mining.

California Drift Mining. An illustrated detailed account of this industry. 2000 w. Min & Sci Pr—Nov. 25, 1899. No. 31138.

Fine Gold.

Loss of Fine Gold in Gippsland. Donald Clark. Concerning the serious loss that occurs in the treatment of the gold. 3200 w. Aust Min Stand (special)—June 1, 1899. No. 31352 D.

Gippsland.

The Gippsland District. An illustrated account of this district, its geological features, mines, etc. 16000 w. Aust Min Stand (special)—June 1, 1899. No. 31351 D.

Gold Deposits.

A List of Some of the Rocks and Minerals in Which Gold Has Been Found. E. Lidgey. 900 w. N. Z. Mines Rec—Oct. 16, 1899. No. 31450 B.

Gold Mills.

The Silver Plating of Amalgam Plates for Gold Mills. Allan Jay Clark. Illustrates and describes the plant installed for retreatment of these plates, at Lead, South Dakota. 3000 w. Sch of Mines Quar—Nov., 1899. No. 31648 D.

Maryborough.

The Maryborough District. An illustrated description of the gold fields, their value, important reefs, etc. 15300 w. Aust Min Stand (special)—June 1, 1899. No. 31355 D.

Mercur Mines.

De La Mar's Mercur Mines, Utah. H. L. J. Warren. Part first gives a brief account of the mines, the rock formation and character of the ores, describing the operations of mining and method of extraction. Ill. 2000 w. Eng & Min Jour—Dec. 23, 1899. No. 31494.

Mexico.

The Tajos Mine, Mexico. Frank B. Fowler. Describes these mines as an evidence of American energy and talent.

900 w. Eng & Min Jour—Dec. 2, 1899. No. 31188.

Nuggets.

The Origin of Nuggets. A. Liversidge. An illustrated account of investigations, with statement of conclusions. 3000 w. Aust Min Stand (special)—June 1, 1899. No. 31359 D.

Victorian Nuggets. Describes some of the interesting nuggets found, the number being greater than in any other part of the world. 3700 w. Aust Min Stand (special)—June 1, 1899. No. 31360 D.

Placers.

The Bear Gulch Placers, Montana. Fred D. Smith. Brief account of recent working of this field. Ill. 600 w. Eng & Min Jour—Dec. 23, 1899. No. 31495.

Precipitation.

Electrical Precipitation of Gold. Edgar Smart. Explains the principal features of the ore treatment process, and the apparatus used. 2800 w. Aust Min Stand (special)—June 1, 1899. No. 31362 D.

Republic Mine.

The Republic Mine, Washington. M. H. Joseph. An account of this mine and the changes made during the past year. Ill. 3200 w. Eng & Min Jour—Dec. 16, 1899. No. 31396.

Victoria.

The Mining District. William Bradford. An illustrated account of its geological features, principal mines, systems employed, etc. 17000 w. Aust Min Stand (special)—June 1, 1899. No. 31346 D.

IRON AND STEEL.

Armor Plates.

The Armor Plate Imbroglio. An extract from a memorandum prepared by Admiral O'Neil, discussing the advantages of the Krupp process and the advisability of a government armor-plate plant. 4000 w. Ir Age—Dec. 21, 1899. No. 31434.

The Manufacture of Armor-Plates at Sheffield. Illustrates and describes the Cyclops Works of C. Cammell & Co., Ltd. 3700 w. Ir & Coal Trds Rev—Dec. 15, 1899. No. 31615 A.

Blast Furnaces.

The Evolution of the Blast Furnace. A. H. Sexton. Extract from a paper read before the Phil. Soc. of Glasgow. Showing how modern methods of iron production are related to the ancient methods. 1400 w. Mines & Min—Dec., 1899. No. 31253 C.

The Youngstown Blast Furnaces of the National Steel Company. An illustrated detailed description of this new furnace plant. 4000 w. Ir Age—Dec. 21, 1899. No. 31433.

Furnace Gases.

See Gas Engineering.

German Opinions.

A German Expert View of the American Iron and Steel Industries. Translation from the *Berliner Tageblatt*. Concerning the significance of the commercial museum at Philadelphia. 1200 w. U. S. Cons Repts, No. 594—Dec. 4, 1899. No. 31168 D.

Iron Manufacture.

The Development of Iron Manufacture in the United States in the Past Seventy-five Years. John Fritz. Full address delivered on the occasion of the celebration of the seventy-fifth anniversary of the Franklin Institute. History of the early developments in the United States. 8000 w. Jour Fr Inst—Dec., 1899. No. 31297 D.

Iron Ores.

Some Common Iron Ores. Considers varieties of the magnetites, hematites, and carbonates. 2200 w. Eng & Min Jour—Dec. 16, 1899. No. 31399.

Lake Superior.

Lake Superior Iron Mines. Dwight E. Woodbridge. An account of what has been done during the past year and the preparations for the coming year. Mines & Min—Dec., 1899. No. 31252 C.

Martin Process.

Improved Martin Steel Process. A. Sattmann, in *Stahl und Eisen*. Description, with illustrations showing the general arrangement of the plant. 2800 w. Col Guard—Nov. 24, 1899. No. 31217 A.

Ohio.

The Iron Industry of Jackson County, Ohio. S. S. Knight. Gives history of this region, aiming to show its suitability for the location of blast furnaces—4000 w. Ir Age—Dec. 7, 1899. No. 31265.

Pig Iron.

Sandless Pig Iron. Thomas D. West. On the advantages of sandless pig iron. 2400 w. Am Mach—Dec. 28, 1899. No. 31631.

Steel.

Purified Open-Hearth Steel vs. Crucible Steel. Richard Moldenke. Reviews an article by Otto Thallner, in *Stahl und Eisen*, discussing the differences, and showing how an advantage is gained by remelting open-hearth steel in the crucible. 1800 w. Ir Trd Rev—Nov. 30, 1899. No. 31135.

Steel Pressing.

The Pressing of Steel; With Especial

Reference to Economy in Transportation. Henrik V. Loss. Describes a series of experiments giving a general view of the results. Ill. 2500 w. Jour Fr Inst—Dec., 1899. Serial. 1st part. No. 31298 D.

MINING.

Bitumen.

Phenomena Attending the Accumulations of Bitumen. A. S. Cooper. Describes phenomena observed in California. Ill. 1200 w. Min & Sci Pr—Dec. 2, 1899. Serial. 1st part. No. 31262.

Blasting.

Blasting by Electricity. Describes briefly the applications of electricity to methods of discharging explosives, discussing the advantages and disadvantages. 1500 w. Min & Sci Pr—Dec. 9, 1899. No. 31340.

Boring.

The Historical Development of Boring (Die Bohrtechnik in Ihrer Historischen Entwickelung). An address by Oberbergrat Tecklenburg, reviewing the development of deep boring for mining and prospecting. 3500 w. Glückauf—Dec. 9, 1899. No. 31545 B.

Caving System.

The Caving System of Mining. E. F. Brown. Illustrated description of the method employed in the Pewabic mine, at Iron Mt., Mich. 2500 w. Min & Sci Pr—Dec. 9, 1899. No. 31339.

Drilling.

Diamond Drilling. H. M. Lane. Notes on the different devices and methods used in drilling, showing the circumstances which necessitate their application and the dangers to be guarded against. 4400 w. Mines & Min. Dec., 1899. No. 31248 C.

Electric Power.

Electric Power Transmission in Mining (Die Elektrische Kraftübertragung im Bergbau). A. Bloemendal. Especially discussing the successful installation of polyphase plants in German mines. 4000 w. Stahl und Eisen—Nov. 15, 1899. No. 31593 D.

Electrical Transmission of Power in Mines. A. Bloemendal. From *Stahl und Eisen*. Illustrates and describes several installations, and discusses the advantages of the polyphase system. 3700 w. Col Guard—Dec. 1, 1899. No. 31336 A.

Fans.

Screw Fans. Charles H. Innes. Read before the N. E. Coast Inst. of Engs. and Shipbuilders. Illustrates and describes the methods of obtaining a reasonable efficiency of these fans. 700 w. Col Guard—Dec. 15, 1899. No. 31620 A.

Haulage.

Underground Haulage by Locomotives. M. J. Kersten. From a communication to the *Annales des Mines de Belgique*. Discusses the systems of haulage used when the mine workings are too sinuous for chain or rope haulage. Ill. 2500 w. Col Guard—Dec. 1, 1899. No. 31335 A.

Miner's Lamp.

The Storage of Electrical Energy and How It Affects Sparking. Sydney F. Walker. The writer's explanation of points brought out in a controversy with Mr. Halbaum on the subject of the comparative safety of the portable electric mining lamp. 2500 w. Col Guard—Dec. 15, 1899. No. 31619 A.

Mining Law.

An Important Tunnel Decision. Full text of the Colorado Supreme Court regarding the ownership of mineral where a tunnel site crosses prior locations. 17500 w. Min & Sci Pr—Dec. 9, 1899. No. 31338.

Victorian Mining Law. Joseph Woolf. Summary of statute law and regulations. 4000 w. Aust Min Stand (special)—June 1, 1899. No. 31358 D.

Ore Deposits.

Popular Fallacies Regarding Ore Deposits. Albert Williams, Jr. Some information of interest to miners of the precious metals. 1800 w. Can Min Rev—Nov. 30, 1899. No. 31154 B.

Progress.

Three-Quarters of a Century's Progress in Mining and Metallurgy. Charles Kirchhoff. Full address reviewing progress, delivered on the occasion of the celebration of the Seventy-fifth Anniversary of the Franklin Institute. 5000 w. Jour Fr Inst—Dec., 1899. No. 31296 D.

Pumping.

See Mechanical Engineering, Hydraulics.

Shafts.

Simultaneously Deepening and Lining a Belgian Colliery Shaft. Julien Linet. From a communication to the Assn des Engs. Sortis de l'Ecole de Liége. Illustrates and describes the work, stating the conditions. 2400 w. Col Guard—Nov. 24, 1899. No. 31218 A.

The Sinking of Shafts in Coal Measures (Approfondissement d'un Puits dans le Terrain Houiller). J. Linet. A description of a method of deepening the shafts of collieries and simultaneously lining them with monolithic walls of concrete. 4000 w. 3

plates. Rev Univ des Mines—Oct., 1899. No. 31575 G.

Siberia.

Auction of Siberian Mining Land. Details in regard to the leasing by auction of gold-mining territory. 2800 w. U. S. Cons Repts, No. 595—Dec. 5, 1899. No. 31166 D.

Timbering.

Colliery Timber and Timber Calculations. George Johnson. Shows the methods of calculating and discusses the usual practice in the timber trade in England. 2000 w. Col Guard—Dec. 8, 1899. No. 31417 A.

The Timbering of Shallow Veins (Ueber Den Abbau Schmaler Flötze). A description of the system which made it practicable to work veins 50 to 60 centimetres thick, with dips of 40° to 45°. 1500 w. Glückauf—Dec. 9, 1899. No. 31544 B.

Veins.

The Walls of Mineral Veins. Reviews opinions as to the relation of mineral veins to their walls, and gives conclusions of S. F. Emmons as to the origin of the Leadville ore deposits. 1500 w. Min & Sci Pr—Nov. 25, 1899. No. 31139.

Winding.

On the Relative Positions of Drums and Pulleys in Winding Arrangements. George W. Westgarth. Read before the South Wales Inst. of Engs. Gives information to determine the most economic lines, from a rope point of view, for the relative positions of the drum and pulley for pits from 100 to 1200 yards winding depth. 2700 w. Ir & Coal Trds Rev—Dec. 15, 1899. No. 31614 A.

MISCELLANY.

Aluminum.

Aluminum and Its Uses and Treatment. J. H. Henderson. Abstract of a paper read before the Manchester Junior Elec. Engs. Describes the methods of extraction, and its peculiarities as an electrical conductor. 1000 w. Ind & Ir —Dec. 15, 1899. No. 31612 A.

Bismuth.

Bismuth Ores in Tasmania. E. M. Weston. Part first describes the Belmont district as regards the local conditions and deposits. 1400 w. Aust Min Stand —Nov. 9, 1899. Serial. 1st part. No. 31448 B.

Graphite.

A Graphite Mine. R. H. Palmer. Describes the deposit in the town of Cranston, R. I., and its working. 900 w. Eng & Min Jour—Dec. 9, 1899. No. 31278.

High Temperatures.

The Goldschmidt Process for Producing High Temperatures (Ueber das Goldschmidtsche Schweissverfahren). A discussion of the results of experience with the use of aluminum for the production of very high temperatures. 1200 w. Glückauf—Dec. 2, 1899. No. 31543 B.

Nickel.

Nickel Mining in Ontario. Extracts from article in the *Toronto Globe* concerning the value of the product and arrangements for the development of the industry. 900 w. U. S. Cons Repts, No. 604—Dec. 15, 1899. No. 31384 D.

Ore Dressing.

The Progress in Ore Dressing. C. Blömcke. Translated from the *Berg- und Huttenmannisches Jahrbuch*. Describes the Lührig system as applied in modern mills,, discussing the advantages and disadvantages. 8500 w. Sch of Mines Quar—Nov., 1899. Serial. 1st part. No. 31647 D.

Rocky Mountains.

Gypsum and Clay. Arthur Lakes. The geological structure and economic values contained in the foothills of the Rockies near Loveland, Colorado. Ill. 2800 w. Mines & Min—Dec., 1899. No. 31255 C.

Separating.

The Development of the Magnetic Separator (Die Entwicklung der Magnetischen Aufbereitung). E. Langguth. A review of the history of early attempts to separate minerals by magnetism, and a discussion of the later methods applied in practice. 1800 w. Zeitschr f Elektrochemie—Dec. 7, 1899. No. 31562 G.

South Africa.

John Hays Hammond on the South African Situation. Chas. B. Going. An interview with the leading authority on the mines of the Rand, containing a fully authorized expression of his views of the present situation and the industrial future of the country. 3500 w. Engineering Magazine—Jan., 1900. No. 31585 B.

The Development of the Transvaal (Du Développement du Transvaal). G. Braecke. A carefully written account of the history and development of the mineral industry of the Transvaal, as seen from a Belgian point of view. 8000 w. Rev Univ des Mines—Nov., 1899. No. 31580 G.

Tin.

The Occurrence of Tin. A. Selwyn Brown. Describes the deposits in various localities, and some of the singular features. 1700 w. Aust Min Stand—Nov. 9, 1899. Serial. 1st part. No. 31449 B.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in October. Detailed list with classified summary and remarks. 5500 w. R R Gaz—Dec. 15, 1899. No. 31375.

Train Accidents in the United States in November, 1899. Detailed list and classified summary. 4500 w. R R Gaz—Dec. 29, 1899. No. 31629.

Fast Runs.

Another Record Breaking Train. An account of the runs of what is known as the "War Express," between London and Manchester, Eng. 700 w. Loc Engng—Dec., 1899. No. 31150 C.

Freight Movement.

Car Famines and Railway Terminals. On the delay caused by lack of facilities for unloading. 1400 w. Eng News—Dec. 21, 1899. No. 31463.

Speeds.

French and English Railway Speeds. Charles Rous Marten. Letter aiming to show that Mr. Burtt's comparisons were not quite fair. 1700 w. Transport—Nov. 24, 1899. No. 31230 A.

FINANCIAL.

Railway Systems.

Great Railway Systems of the World. A condensed statement giving much information. 900 w. Ry Age—Dec. 1, 1899. No. 31186.

Siberia.

Wages and Living on the Siberian Railway. L. Lodian. An account of the poor pay of Russian railway employees and how they live. Ill. 1400 w. Loc Engng—Dec., 1899. No. 31145 C.

LEGAL.

Pools.

Pooling of Locomotives. M. E. Wells. Extracts from a paper presented at Nov. meeting of the W. Ry. Club. Explains the working of the pool, and discusses its advantages. 1600 w. R R Gaz—Dec. 15, 1899. No. 31372.

Mr. Ripley on Pools and State Regulation of Railroads. A reply to the assertions of George F. Stone. Extract from paper submitted to the Congressional Committee. 1300 w. R R Gaz—Dec. 1, 1899. No. 31161.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Inspection and Maintenance of Air Brake Equipment. Discussion at the November meeting. 6000 w. Cent Ry Club—Nov., 1899. No. 31306 C.

Coal Cars.

The Canda 100,000-Pound Capacity Coal Cars. Illustrated description of the interesting features. 1200 w. Ry Age—Dec. 22, 1899. No. 31492.

Couplers.

Defects in Coupler Unlocking Gear. Editorial review of an interesting document sent out by the Interstate Commerce Commission. 1100 w. R R Gaz—Dec. 15, 1899. No. 31376.

Cylinder Power.

Cylinder Power of Compound Locomotives. G. R. Henderson. Discusses the ratio of tractive power to weight, showing the simple locomotive to have an advantage over the compound. 700 w. Am Engr & R R Jour—Dec., 1899. No. 31180 C.

Draft.

Draft Appliances and Extended Smoke Boxes. Editorial on paper by Snowden Bell, read before the Western Ry. Club, reviewing progress in draft appliances. 1500 w. Loc Engng—Dec., 1899. No. 31148 C.

Flange Wear.

Flange Wear of Car Wheels. Editorial discussing the increase in flange wear of late and the causes. 1600 w. R R Gaz—Dec. 22, 1899. No. 31458.

Locomotives.

American and Indian Built Engines. Photographs and description of American locomotives ordered for the Bombay-Baroda and Central India Ry. Also photograph and plan showing details of the first locomotives entirely constructed in India. 1800 w. Ind & East Engr—Nov., 1899. No. 31386 D.

American Locomotives for the Barry and Port Talbot Railways. Illustrated description of tank engines of English type, with some American features. 1000 w. Engr, Lond—Dec. 8, 1899. No. 31426 A.

A Pittsburg Standard Passenger Locomotive. Illustrated description of an engine recently built for the K. C., F. S. & M. Ry. 300 w. Loc Engng—Dec., 1899. No. 31149 C.

A Very Heavy Consolidation Engine for the Illinois Central. Full illustrated description of the 108-ton consolidation locomotive built by the Rogers Locomotive Works, of Paterson, N. J. 1700 w. R R Gaz—Dec. 15, 1899. No. 31374.

Colliery Locomotives. W. W. Clayton. From Trans. of the Institution of Min. Engs. Concerning their use and abuse, and the points that should be watched and what should be avoided in their construction. 2300 w. Mines & Min—Dec., 1899. No. 21256 C.

Compound Freight Locomotive (Locomotive Compound à Marchandises). Description and illustrations of heavy compound goods engine constructed for the Belgian State Railways. The weight is supported entirely on the drivers and the engines are to work on a grade of 3.12 per cent. 2000 w. Revue Technique —Nov. 10, 1899. No. 31509 D.

Consolidation Pushing Locomotive. Illustrated description of an engine for the D. & H. Co., using fine anthracite coal, and having an exceptionally powerful boiler for the weight. 600 w. Am Engr & R R Jour—Dec., 1899. No. 31182 C.

Locomotive Road Tests. W. H. Lewis. An interesting series of tests to ascertain the relation between the fuel consumption and the work performed. 2000 w. Am Engr & R R Jour—Dec., 1899. No. 31181 C.

Player Tandem Compound Ten-Wheel Passenger Locomotive. Illustration, with description, of a locomotive for high-class passenger service. 1300 w. Ry & Engng Rev—Dec. 9, 1899. No. 31310.

Rogers Locomotive for the Illinois Central. An engine of the consolidation type which is among the largest ever built. Illustration and detail drawings. 2000 w. Ry Age—Dec. 15, 1899. No. 31404.

Some Fundamental Distinctions in Locomotive Types. Editorial on the various types, the factors which enter into the selection of a type, and their limits. 1300 w. R R Gaz—Dec. 15, 1899. No. 31377.

Ten-Wheel Compound Freight Locomotives. Illustrated description of engines with piston valves on high-pressure cylinders, for use on the Northern Pacific Ry. 1200 w. Am Engr & R R Jour—Dec., 1899. No. 31179 C.

Lubrication.

Lubrication of Freight and Passenger Equipment. Discussion at the November meeting. 3300 w. Cent Ry Club—Nov., 1899. No. 31307 C.

Rail-Sawing.

Rail-Sawing and Drilling Car; Chicago, St. Paul, Minneapolis & Omaha Ry. Illustrated detailed description. 800 w. Eng News—Dec. 7, 1899. No. 31285.

St. Gotthard.

The Ventilation Plant for the St. Gotthard Tunnel (Lüftungs-Anlage für den Gotthard-Tunnel). A description of the Saccardo system recently installed at the Göschenen end of the tunnel. Diagrams showing the movement of trains and the velocity of air are given. 1800 w. 2 plates. Glaser's Annalen—Dec. 1, 1899. No. 31537 D.

Sanitation.

Railroad Sanitation. Abstract of discussion at the New England Railroad Club in Boston. Calls attention to some things that need correction. 2900 w. R R Gaz—Dec. 29, 1899. No. 31627.

Springs.

Stiffer Drawbar Springs. Claims that the strength of the drawbar springs should be increased in proportion to the increase in the tractive power of the locomotive. 600 w. Loc Engng—Dec., 1899. No. 31147 C.

Stays.

Crown and Cross Stays—Mexican Central. Illustrated description of the standard crown and cross stays used on this road. 700 w. R R Gaz—Dec. 29, 1899. No. 31628.

Steel Cars.

Economy of Mineral Transport. An illustrated article showing the present state of steel wagon construction in England. 4300 w. Ir & Coal Trds Rev—Dec. 1, 1899. No. 31333 A.

The Steel Car. An account of the development. 2000 w. R R Car Jour—Dec., 1899. No. 31337.

Train Heating.

The Heating of Railway Trains by Steam (Chauffage des Trains à la Vapeur). E. Belleroche. A discussion of the Lancrenon and Dery system, using mixed air and steam. 4000 w. 3 plates. Rev Univ des Mines—Nov., 1899. No. 31581 G.

Train.

The Alton Limited. Gives four fine plates illustrating the daylight limited train recently placed in service on the Chicago & Alton, between Chicago and St. Louis. 1200 w. Ry Age—Dec. 8, 1899. No. 31309.

NEW PROJECTS

Africa.

Railways of Africa. Map showing the extent of railway development, and a statement of the feeling in France concerning the demand for more rapid building of railways. 350 w. U. S. Cons Repts, No. 600—Dec. 11, 1899. No. 31295.

The Construction of the German East-African Central Railway (Der Bau der Deutsch-Ostafrikanischen Centralbahn).

A discussion before the German Railway Association giving an account of the proposed routes, with estimates of cost. 2000 w. Glaser's Annalen—Dec. 1, 1899. No. 31536 D.

Railway Schemes.

Railway Schemes in Parliament. Editorial discussion of schemes to be brought before the next session of the British Parliament. 5400 w. Engng—Nov. 24, 1899. No. 31207 A.

Siam.

The Railroads of Siam. Information concerning the roads built, and the need of new roads. 1300 w. R R Gaz—Dec. 22, 1899. No. 31456.

Transcontinental.

The Canadian Northern Railway and the Great Northern of Canada. Describes a proposed route across Canada. 1100 w. R R Gaz—Dec. 22, 1899. No. 31457.

PERMANENT WAY AND FIXTURES.

Boston Station.

The Mechanical Equipment of the New South Station, Boston, Mass. Walter C. Kerr. The various sections are described by those who designed them or were connected with the work. A full illustrated description of engineering appliances. 25800 w. Trans Am Soc of Mech Engs. No. 849—Dec., 1899. No. 31257 D.

Extension.

The "Boston and Providence Extension." An illustrated description of some of the problems in engineering in the extension from Huntington Ave., Boston, to the new South Terminal. 1400 w. R R Gaz—Dec. 8, 1899. Serial. 1st part. No. 31291.

Improvements.

Line Improvements on the New South Wales Government Railways. Illustrated particulars concerning improvements in permanent way and structures during the period of government ownership. 1300 w. Ry & Engng Rev—Dec. 9, 1899. No. 31313.

New York Central Improvements at Hoffman's, N. Y. Describes a connection made between the N. Y. C. and the West Shore railroads, to facilitate the use of the West Shore tracks. 900 w. Ry Age—Dec. 22, 1899. No. 31491.

Japan.

Railways in Japan. A résumé of the last annual report of the imperial Japanese railway bureau. 900 w. Cons Repts, No. 593—Dec. 2, 1899. No. 31-124 D.

New Line.

The Construction of the Rutland Canadian Railroad. Map and description of a line under construction in the eastern part of the United States, 47 miles in length. 1000 w. Eng News—Dec. 21, 1899. No. 31464.

The Great Northern Railway. Illustrates and describes the new branch line and the goods station at Leeds. 1600 w. Engr, Lond—Nov. 24, 1899. No. 31214 A.

Peru.

The Central Railroad of Peru. Engravings and information concerning a road built under exceptional difficulties. 900 w. R R Gaz—Dec. 22, 1899. No. 31455.

Pittsburg Station.

The New Terminal Station of the Pittsburg & Lake Erie Terminal R. R. at Pittsburg, Pa. Burcham Harding. Detailed description of the engineering equipment of a very complete station. 2000 w. Eng News—Dec. 7, 1899. No. 31287.

Rail Deflections.

Investigations on the Temporary Deformations of Rails (Versuche über die vorübergehenden Formänderungen des Geleises). Alfred Birk. A résumé of experiments made upon the Vienna-Warsaw railway, with illustrations of the photographic recording apparatus employed. 5000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1899. No. 31532 D.

Rail Joints.

Clark Fisher's "Triple Fish" Rail Joint. Illustrated description. 800 w. R R Gaz—Dec. 8, 1899. No. 31294.

R. R. Building.

The Year's Railroad Building. A brief review of new construction in the United States during the year ending Dec. 31, 1899. 600 w. R R Gaz—Dec. 22, 1899. No. 31459.

Railroad Engineering.

The Lancashire, Derbyshire & East Coast Railway. Illustrated description of a line in Great Britain, especially interesting on account of the character of the country traversed and difficulties surmounted. 1100 w. Engng—Dec. 15, 1899. Serial. 1st part. No. 31616 A.

Signals.

Railway Signals. C. Francis Jenkins. Brief illustrated description of the "block system" and the latest system which is a combination of the manual and automatic. 1000 w. Sci Am—Dec. 9, 1899. No. 31258.

Yellow Signal Lights. Editorial, stating the considerations pro and con

as taken by the N. Y., N. H. & H. R. R., and discussing the objections and advantages. 1400 w. R R Gaz—Dec. 8, 1899. No. 31292.

Soudan.

The Military Railway of the Soudan (Le Chemin-de-Fer Militaire du Soudan). A general description of the railway and a special discussion of the Atbara bridge. 2000 w. Revue Technique —Nov. 10, 1899. No. 31508 D.

Station.

Proposed Northern Pacific Station at Seattle, Wash. Illustration and ground floor plan, with brief description. 600 w. Ry & Engng Rev—Dec. 9, 1899. No. 31312.

Steel Ties.

Steel Ties in Mexico. Gives particulars concerning the design of the ties and the methods of maintaining track laid. Also states the advantages and disadvantages shown by experience. Ill. 1200 w. Ry & Engng Rev—Dec. 23, 1899. No. 31493.

Velocity Grades.

The Theory of Velocity Grades. Charles C. Wentworth. Mathematical demonstrations of the advantages in handling tonnage in connection with velocity grades. 1100 w. R R Gaz—Dec. 8, 1899. No. 31290.

TRAFFIC.

Paris Exposition.

Facilities for Handling Crowds at the Paris Exposition. Abstract translation from *Le Chemin de Fer*. Brief account of the arrangements being made for the transportation of the immense crowds expected. 1100 w. Ry & Engng Rev—Dec. 2, 1899. No. 31201.

Railways.

English and American Railways. A discussion of the American side. The present article considers rates and earning capacity, first cost, operating expenses, etc. 4200 w. Engr, Lond—Dec. 1, 1899. Serial. 1st part. No. 31343 A.

Rates.

The Railroads and the Farmers. W. M. Acworth. From the Trans. of the Surv's Inst., London. On the English rates for the conveyance of agricultural products. 1600 w. R R Gaz—Dec. 1, 1899. No. 31162.

STREET AND ELECTRIC TRAMWAYS

Berlin.

Plan for the Introduction of Electric Power Upon the Berlin City and Belt Railway (Projekt über die Einführung des Elektrischen Betriebes auf der Berliner Stadt-und Ringbahn). A full account of the proposed change of the Berlin elevated railway from steam to electric power, with estimates of the cost. Also editorial. 10000 w. Elektrotech Zeitschr—Nov. 16, 1899. No. 31547 B.

The Berlin Underground Railway (Berliner Untergrundbahn). A brief description of the electric tramway between Treptow and the Silesia Railway Station. Excellent illustrations of the tunnel under the river Spree are given. 800 w. Ill. Zeitschr f Klein u Strassenbahnen—Dec. 1, 1899. No. 31577 D.

Bonding.

Cast Welding on the Calumet, Chicago. Illustrated description of the outfit to be used in cast-welding about 80 miles of track. 1800 w. St Ry Rev—Dec. 15, 1899. No. 31401 C.

Brake.

Eddy-Current Brake for Electric Tramways (Wirbelstrombremse für Strassenbahnwagen). Describing the improved device of the Helios Company, in which the electrical and mechanical brakes are united. 1200 w. Elektrotech Zeitschr—Dec. 7, 1899. No. 31556 B.

Buffalo, N. Y.

System of the International Traction Co., of Buffalo, N. Y. An illustrated description of the interurban lines, the Niagara Falls power equipment, stations, welded rail joints, etc. 5800 w. St Ry Rev—Dec. 15, 1899. No. 31400 C.

Car-Building.

Quality in Car Building. Discusses some of the false ideas in regard to cars and car-building, giving information on important points. 2500 w. St Ry Rev—Dec. 15, 1899. No. 31402 C.

Conduit Construction.

Electric Conduit Construction in Paris. A. N. Connett. An illustrated description of a construction differing quite radically from the usual, and using the side slot conduit. 3200 w. St Ry Jour—Dec., 1899. No. 31238 D.

Contact System.

The Kingsland Contact System. Illustrated description of a system to be soon tried at Wolverhampton. 800 w. Elec Eng, Lond—Nov. 24, 1899. No. 31229 A.

Earnings.

Transportation Earnings and Profits on Manhattan Island. Reviews the

changes brought about during the last fifteen years, by which the lines have passed within the control of three competing systems, and the changes in traffic and increased earnings. 5200 w. St Ry Jour—Dec., 1899. No. 31243 D.

Electric Supply.

The Supply of Electric Energy for Traction Purposes. Philip Dawson. Discusses the best method of generating for this purpose, and the differences between lighting and traction, offering suggestions of value. 2500 w. Elec Rev, Lond—Nov. 24, 1899. No. 31221 A.

Electrolysis.

Electrolysis in American Cities. F. A. W. Davis. Read before the Central States Water-Works Assn., at Cincinnati. Illustrations of damaged pipe from various cities are given, with discussion of the remedy. 3400 w. Munic Engng—Dec., 1899. No. 31123 C.

Electrolysis of Cast-Iron Water-Mains. Lucien I. Blake. Calls attention to the dangers to cast-iron mains, even without the so-called electrolytic danger areas, illustrating by examples. 1300 w. Elec Wld & Engr—Dec. 16, 1899. No. 31408.

English Tramway.

The Manchester Tramway System. F. Brocklehurst. Explaining the system now existent, the steps taken toward municipalization, and the proposed expenditure. Ill. 3000 w. Tram & Ry Wld—Dec. 7, 1899. No. 31453 A.

Franchise Requirements.

Street Railways in Foreign Cities and Their Franchise Requirements. From a pamphlet issued by the Royal Trust Co. Bank, of Chicago. Ill. 2200 w. Eng News—Nov. 30, 1899. No. 31160.

Interurban.

The St. Louis & Belleville Electric Ry. An illustrated description of a well-built line. 1800 w. St Ry Rev—Dec. 15, 1899. No. 31403 C.

London.

The Tramway Policy of the London County Council. Clarence E. Ady. A sketch showing the importance of the operations and their far-reaching effect. 3500 w. Tram & Ry Wld—Dec. 7, 1899. No. 31454 A.

Manhattan Elevated.

The Manhattan System—What Electricity Will Accomplish. Burton Ellinwood Greene. On the advantage to be gained by electrical equipment. 1200 w. Elec Rev, N. Y.—Nov. 29, 1899. No. 31137.

Power Station.

The New Power Station for the Metropolitan Street Railway Company. Illustrated description of a station containing 11 engines developing 60,000 H. P., with accessory boiler plant, generators and minor apparatus for furnishing alternating current to the substations of 220-mile railway system, at which it will be transformed to direct current. The details of the building as well as the power plant are described. 6200 w. Eng Rec—Dec. 23, 1899. No. 31475.

Test of the Power Plant of the Capital Traction Co., Washington, D. C. Data abstracted from theses of graduates of Cornell Univ., prepared from results of tests made by them. 800 w. Eng News—Dec. 28, 1899. No. 31645.

Rapid Transit.

General Structural Details of the New York Rapid Transit Tunnel Railway. Illustrates the details as finally decided upon by the commission, with description of route and explanation of drawings. 2300 w. Eng News—Dec. 14, 1899. No. 31366.

Stray Currents.

Stray Currents and the Stability of Structures. Editorial, discussing the effect upon observatories, the Brooklyn Bridge and other structures. 2300 w. Engng—Dec. 8, 1899. No. 31416 A.

Subway.

Subway at Kingston, N. Y. Illustrated description of an interesting piece of construction work, by which a five-track grade crossing with a steam railroad is avoided. 1300 w. St Ry Jour—Dec., 1899. No. 31240 D.

Switzerland.

Important Three-Phase Electric Railway in Switzerland. Charles Rochat. Illustrates and describes the road connecting Burgdorf and Thun. 2500 w. St Ry Jour—Dec., 1899. No. 31239 D.

The Swiss Railway Between Burgdorf and Thun and Stanz and Engelburg (Die Schweizer Bahnen Burgdorf-Thun und Stanz-Engelberg). A discussion before the German Railway Association of two Swiss electric railways operated from hydraulic power and overcoming steep gradients. 2000 w. Glaser's Annalen—Dec. 1, 1899. No. 31535 D.

Transportation.

Mechanical Propulsion and Traction. G. Forestier. Part first considers animal traction, and the reasons for substituting mechanical, and the progress made. Ill. 4800 w. Auto Mag—Dec., 1899. No. 31132 C.

Underground Ry.

Will the Proposed Underground Railway in New York Pay? Describes the route, giving map, and also details of the project, discussing the financial requirements, etc. 2500 w. St Ry Jour—Dec., 1899. No. 31242 D.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

S. Morgan Smith Co., York, Pa., U. S. A.—Descriptive catalogue of the McCormick turbine, with tables of dimensions and capacities, and numerous illustrations of hydraulic-power plants in various parts of the world where the wheels are in use. Tables of weirs, and of velocities and discharges of water from pipes are appended, rendering the catalogue useful for reference.

The Fred. W. Wolf Co., Chicago, Ill., U. S. A.—Catalogue of the Linde ice and refrigerating machines, containing extensive lists of users of the Linde machines in Europe, America, Africa, and Asia, both for refrigeration and for the artificial manufacture of ice.

Warner & Swasey, Cleveland, O., U. S. A.—Illustrated catalogue of machine tools for iron and brass work, including revolving-turret screw machines of various kinds. Full specifications of the various kinds are given. The catalogue also contains descriptions of monitor lathes, forming lathes, automatic boring and tapping machines and special milling and boring machines. Useful mechanical tables are appended.

Charles E. Billin & Co., Chicago, Ill., U. S. A.—Vol. I., No. 10, of serial catalogue of machinery and supplies for mines and mills. In addition to the mining supplies catalogue, there are given various articles of interest reprinted from current publications, together with a complete index including all the previous issues.

The Carborundum Co., Niagara Falls, N. Y., U. S. A.—Pamphlet entitled "The Basis of Manufacturing Economy," discussing the advantages of high-grade abrasive materials and showing the advantages of Carborundum for all purposes where emery and corundum were formerly employed.

Rand Drill Company, New York.—Catalogues *(a)* of rock drills and mountings; *(b)* of air and gas compressors. Both are remarkably handsome specimens of the printer's art, and both contain much useful information concerning the production and utilization of compressed air in rock drilling.

Odorless Excavating Company, Boston, Mass., U. S. A.—Illustrated catalogue of odorless pumps and apparatus for removing the contents of vaults and cess-pools. Various forms of apparatus and accessories are shown, and numerous testimonials from municipal and individual users are given.

Merrill Pneumatic Pump Co., New York.—Pamphlet catalogue illustrating and describing the Merrill pump, operated by the direct action of the compressed air, and giving many testimonials from users in various parts of the United States.

A. A. Griffing Iron Co., Jersey City, N. J., U. S. A.—Pamphlet illustrating and describing the various Bundy steam specialties made by this firm, including steam and oil separators, feed-water heaters, low-water alarms, and steam traps.

The Detrick & Harvey Machine Co., Baltimore, Md., U. S. A.—Catalogues *(a)* of open-side iron planers, extension planers, shaping machines, and special tools and machinery; *(b)* of bolt-threading and nut-tapping machinery. Both catalogues are handsomely illustrated and give much useful information concerning the various tools listed.

Garden City Sand Co., Chicago, Ill., U. S. A.—Neat pamphlet describing fire-brick, Portland and Louisville cement, molding sand, fire sand, and general building and manufacturing supplies. Many useful tables relating to steam, temperatures, specific gravities, etc., are given.

American Blower Co., Detroit, Mich., U. S. A.—Illustrated sectional catalogue No. 110, describing heaters, fans, and blowers for the heating and ventilation of public buildings, factories, and stores, and the drying of all kinds of materials. Improved forms of heater coils are shown, also disc and pressure fans, together with applications to heating of various kinds of buildings.

Burhorn & Granger, New York.—Catalogue of tanks, boilers, and coils for hot water, elevators, and general purposes, giving full specifications of the various sizes, and other useful information.

Buhl Malleable Co., Detroit, Mich., U. S. A.—General catalogue No. 4, of elevating and conveying machinery and appliances. Illustrations of a full list of malleable-iron chain links are given, together with details of elevator-buckets, sprocket-wheels, elevator-boots, spiral conveyors and other conveying devices. A useful table of speeds and power of driving chain as compared with belting is given, also lists of pulleys and gearing.

Spencer Automatic Screw Machine Company, Hartford, Conn., U. S. A.—Handsomely illustrated catalogue of automatic machines for the manufacture of every variety of machine screws and turned metal parts for bicycle, electrical, gun and other work. Illustrations showing examples of the variety and character of products of the machines are given, and special tools and fixtures shown.

Acme Machinery Co., Cleveland, O., U. S. A.—Illustrated catalogue of bolt and nut machinery, including bolt-cutters, nut-tappers, bolt heading and forging machines. Sectional illustrations of die heads are given, and information about the use and care of dies. Tables of cutting speeds and proportions of threads are appended.

NEW CATALOGUES.

Sprague Electric Company, New York.—Catalogue No. 64, illustrating and describing Lundell electric generators of the direct-connected and belted types. Full details of the construction of the machines are shown, also curves showing the magnetization, pole-face induction and distribution of potential. Regulation and efficiency curves are also given, and tables of dimensions and output of the various sizes. The catalogue is a beautiful example of the engraver's and printer's art.

American Well Works, Aurora, Ill., U. S. A.—Leaflets illustrating and describing vertical and horizontal air compressors, and well sinking machinery of every kind. A portable drilling rig for artesian, oil or water well sinking is shown, also details of deep-well valve parts.

Westinghouse Machine Company, Pittsburg, Pa., U. S. A.—Handsome catalogue of the Westinghouse gas engines, showing by successive sections the phases of the cycle, and exhibiting very clearly the construction of every part. Especial emphasis is given to the method of governing, this being on the principle of regulated charges, not the "hit and miss" system.

New York Central and Hudson River R. R., New York.—Four Track Series, No. 21. Illustrated folder describing a trip 'round the world by way of New York and Niagara Falls, with general information concerning the routes included, and a remarkably fine railway map of the United States, geographically correct, and not modified to the advantage of any particular lines.

Keystone Blue Paper Co., Philadelphia, Pa., U. S. A.—Book of samples of blue-process papers and linen, also list of printing apparatus and sensitizing solution.

Ransome Concrete Company, New York.—Descriptive pamphlet devoted to setting forth the advantages of concrete cold-twisted iron construction, showing the adaptability of concrete reinforced with cold-twisted iron for a great variety of architectural and engineering structures. The fire-proof properties of the construction are emphasized and illustrations of a number of buildings in which it is employed are given.

O. S. Walker & Co., Worcester, Mass., U. S. A.—Catalogue of magnetic chucks for hold work in planing, shaping, and grinding machines. The construction of a variety of these ingenious and effective devices is shown by numerous illustrations, and the advantages and methods of using them clearly set forth.

The Sterling Varnish Company, Pittsburg, Pa., U. S. A.—Catalogue of the Sterling insulating varnish, describing its advantages as an insulating material for armature and field coils, and for a variety of purposes where electrical insulation is desired and the absorption of moisture and oils prevented. A large number of fac-simile testimonials from important electrical manufacturers are given.

Laughlin-Hough Company, New York—Catalogue of improved mathematical drawing tables and supplies, giving illustrations of a number of improved tables for draftsman's use, both for original designing and for detailing.

United States Metallic Packing Company, Philadelphia, Pa., U. S. A.—Fully illustrated pamphlet catalogue of metallic packings for piston rods in every variety of engines, air compressors, and similar machines. The different varieties are well shown by handsome perspective and sectional illustrations, and a form of specification and instructions for ordering are appended.

Ward-Leonard Electric Co., New York.—Catalogue No. 997, containing illustrations of principal types of rheostats and circuit-breakers for every variety of electrical service.

W. P. Phillips, Boston, Mass., U. S. A.—Catalogue of steam engine and boiler appliances, including oil cups, crank-pin oilers, special lubricators, boiler gauges, and gauge cocks.

Union Electric Construction Co., Philadelphia, Pa., U. S. A.—Pamphlet illustrating and describing a closed conduit system for operating street railway cars.

W. W. Clarke & Son, Baltimore, Md., U. S. A.—Architect's hand book of cements, containing much useful information in a compact form, rendering it at the same time a handy reference book and a trade catalogue of cements and kindred building materials.

Boston Belting Co., Boston, Mass., U. S. A.—Pamphlet catalogue of rubber belting, rubber hose, packing, gaskets, tubing, valves, and a great variety of mechanical rubber goods. Interesting information concerning the gathering of crude rubber is given.

Buffalo Forge Company, Buffalo, N. Y., U. S. A.—Catalogue of the special design of steam engine built by this company, showing its adaptability for direct connection to electric generators. A vertical type marine electric generator engine of good design is also shown.

Geo. W. Sherman, Boston, Mass., U. S. A.—Small pamphlet describing "corroproof," a protective coating for metals, applicable for the prevention of corrosion in automatic sprinklers, and for the protection of metallic surfaces generally against the action of acids or alkalies.

Buff & Buff Instrument Co., Boston, Mass., U. S. A.—Illustrated catalogue of engineering, surveying, and mining instruments, showing the improvements and advances which have been made upon the instruments of the former firm of Buff & Berger. Illustrations of the graduating machines used by the firm form an interesting feature.

The Dayton Globe Iron Works Company, Dayton, O., U. S. A.—Fully illustrated catalogue of the New American Turbine, giving data and results of tests, showing the high efficiency at full and part gate; also description of various installations of magnitude. Instructions for the measurement of water powers are appended, and numerous useful tables in connection with the development of water power.

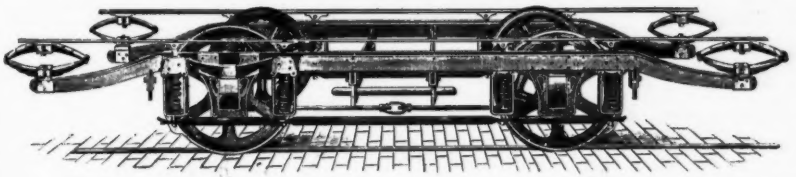
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

New Motor Truck.

THE Dorner motor truck represented in the accompanying engraving is strong and well built, has a long spring base, half elliptic springs over each journal box, spiral springs on each side of the box, held in place by a frame suspended from side bars, thereby insuring easy riding for the passengers, as the car and motors are carried by the half elliptics. It also has four elliptic springs on the ends, preventing the car from oscillating; the side bars are over the top of the journal box, permitting the removal of wheels and axles in a few minutes, while this consumes half a day in trucks where the side bars are beneath the journal. The method of holding the spring posts gives just enough side motion to take curves easily at high speed.



By the system of holding the spiral springs in this truck they may be replaced, in case of breakage, by detaching the spring frame from the side bars, which can be easily done. This is a new feature, and repairs may be made anywhere, it not being necessary to have the car over the pit or elevator. There is also a method of detaching the truck from the car, by releasing the spring posts from the brackets. The construction of the brakes is simple and powerful. An important feature, also, is in the method of suspending the spiral springs, which, instead of being set in a cup on the bottom bar, are suspended in a frame to the side bars. This allows the springs automatically to seek their center of gravity, and lessens the wear in all guiding places in frames.

Other features of the truck will be furnished by the Dorner Truck & Manufacturing Co., Cleveland, Ohio.

Lidgerwood "99" Derrick Engine.

THE engraving shows an improved hoisting engine recently brought out by the Lidgerwood Manufacturing Company, New York, which will be known as their "99" derrick engine with simplex swinging gear. It is of the standard Lidgerwood double-drum type, with a patent attachment for swinging the boom of a derrick, that is believed to be the simplest and most effective device ever designed for that purpose. The small friction drums which are used for the derrick swinging ropes are placed inside the winch heads and occupy very little space, leaving the winch heads available for use the same as with an ordinary double drum engine. Both these swinging drums are actuated by a vertical lever, arranged with a detent and quadrant, so that the lever may be applied and held by the detent in its position, without further attention on the part of the operator. The device is thus easily handled by the operator, and the operations of hoisting the load, raising the boom and swinging the boom, can all go on simultaneously, with practically no more trouble than in handling an ordinary double drum engine.

The winch heads are secured to the shaft by a sliding key or feather, and are of special form, having a sleeve upon which the swinging drum revolves; and a very powerful form of friction is used between the swinging drum and the winch head, so that the full power of the engine can be used. The frictional contact is produced by cams placed between the swinging drums and the frame of the engine, while collars with anti-friction washers are placed on opposite sides of the frame to take up the thrust. The operating cams are connected by links to the end of a lever, which is carried on a rock-shaft extending across to the operating side. In operation a rope is wound on the bull wheel of the derrick, and is secured to the same in the center. Each of the two ends is secured to one of the two swinging drums, enough rope being wound on each to give the required amount of motion to the bull wheel. By throwing the lever forward it engages the friction clutch on that winch, causing it to rotate and wind in the rope which turns the boom in one direction, the other winch meanwhile paying out the rope, as the cams are so constructed that the same movement which engages one friction disengages the other. By throwing the lever forward the friction of the rear friction drum is engaged, and the forward friction drum is released. Thus, the boom can be pulled in either direction.

The cams operating the frictions are so constructed that when the operating lever is in its central position there is enough frictional contact in the swinging drums to

keep the ropes taut, and therefore, when one swinging drum is winding in the rope, the other drum has sufficient friction to prevent the rope which is paying out from overrunning. The means of adjustment is very simple, consisting of a nut on a stud bolt in the outer end of each winch shaft. The construction of the friction is such that there is very little wear, and when the parts are worn, they may be replaced at a trifling cost, without impairing the main parts of the device whatever.

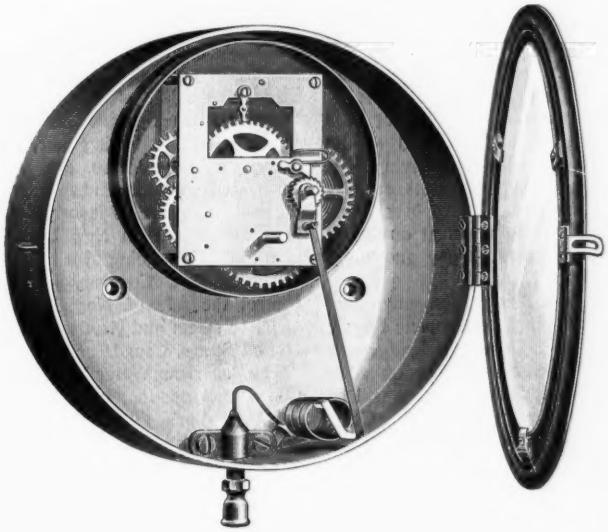
The advantages of this swinging gear are apparent—it occupies a small amount of space, does not add much to the weight of the engine, can be operated with very little exertion, and requires very little time in its operation, on account of the detent lever which holds itself in whatever position placed. One of the most important feature lies in the fact that it can be placed upon any of the Lidgerwood standard double drum hoisting engines, either with or without boiler.

The Lidgerwood Manufacturing Company has issued an attractive hanger, in three colors, of their "99" derrick engine, copies of which will be sent free upon request.

Bristol's Round Recording Gauge.

THE illustration herewith shows an interior view of a new round recording pressure gauge that is being placed on the market by the Bristol Company, of Waterbury, Conn. This new form has been designed to meet a demand for a recording gauge at a lower price than their standard gauges, which have, during the ten years they have been in use, acquired a high reputation for accuracy and durability.

A special feature of the round form is that the dial is located slightly eccentrically to the main body of the case, thus allowing sufficient space on the lower side of the dial for the pen arm to pass out between the dial and the case.



The cut shows the extreme simplicity upon which its accuracy and durability depend to a large degree. The pen arm is directly attached to the free end of a tube of flattened cross-section which is bent into a helical form.

The tendency of pressure applied is to straighten or uncoil the helical tube, which causes the pen arm to move over the range of the chart without the necessity of any intervening multiplying devices.

In order that the advantages of using

recording pressure gauges and other recording instruments may be more generally appreciated, the Bristol Company are filling orders for these instruments with the privilege of returning at end of thirty days' trial if not perfectly satisfactory.

Industrial Notes.

Messrs. Thomas Carlin's Sons, of Allegheny, Pa., have incorporated under the name of Thomas Carlin's Sons Co., and have removed their place of business from 186 Laycock street to 380 River avenue, Allegheny, where the new corporation will conduct the business.

The New York Air Compressor Company's new shops at Arlington, N. J., commenced operation in all departments but the foundry upon January 2, and the company expects to have its foundry at work by February 1. Although organized but little over sixty days, the sales record of the company is remarkable, orders having been placed with it sufficient to tax its capacity for three months. Plans have been made to double the shop equipment at once, and the plant will be operated day and night until this is done.

The Berlin Iron Bridge Company, East Berlin, Conn., are about to complete for the American Ordnance Company, Bridgeport, Conn., a new machine shop with traveling cranes, runways, etc. The building will be covered with the Berlin Iron Bridge Company anti-condensation corrugated iron roof covering.

The Sprague Electric Company removed its offices on December 16, to 527 to 531 West Thirty-fourth street, New York City, where they have larger quarters and better facilities for conducting their large and increasing business.

The Warren Manufacturing Co., Chicago, have recently issued some attractive literature describing their liquid pulley cover. The object sought in the use of this composition is to prevent slipping of belts and facilitate the operation of slack belts. This is done by an enameling process which leaves the pulley with a firm, adhesive and leather-like surface, having natural affinity for belting. Judging from the reports received from the company of their being over run with orders, we are led to believe that the easy application of this cover, together with its other apparent merits, causes the use of this composition to appeal to mechanics as a feasible method of eliminating the annoyances and losses caused by belt slipping.

The Keystone Lubricating Co., Philadelphia, reports a large demand for Keystone lubricating grease in foreign countries, recent shipments including consignments to Mexico, Havana, Cuba; Barcelona, Spain; Buda Pesth, Australia, and Hong Kong.

The Stilwell-Bierce & Smith-Vaile Co., of Dayton, O., has recently established a branch office for St. Louis and vicinity in the Burlington Building of that city, under the management of Mr. Louis Bendit.

Mr. H. C. Farnsworth, who traveled for a number of years throughout the New England States, selling electrical machinery, now represents the Sprague Electric Company in that territory, having offices in the Exchange Building, Boston. Mr. Farnsworth's acknowledged ability and aggressiveness will no doubt stand in his favor, as of yore, and his many friends in New England will be glad to find him going over his old territory.

The Q & C Company now exclusively control the sale of Magnolia anti-friction metal to steam and electric railroads of the United States, Canada and Mexico.

The American Water Works & Guarantee Co., Pittsburg, Pa., have purchased from the New York Filter Manufacturing Co., New York, the New Orleans filter plant of 16,000,000 gallons daily capacity. The American Water Works & Guarantee Co. has already installed the New York Filter Manufacturing Co. various types of filter plants in some eight or ten of its water works in various parts of the country. The filter plant installed in connection with their water works plants at Hornellsville, N. Y., is of the same type as the New Orleans filters just purchased, and is now in satisfactory operation.

The engine which is to furnish the electric light and motive power for the special machinery exhibit of the United States at the Paris Exposition, left New York a short time ago on the U. S. Transport Steamer "Prairie." This engine, which is a tandem compound of 350 horse-power direct connected to a generator, was built by the Ball Engine Co., Erie, Pa.